# Report and Proceedings

OF THE

# BELFAST

# NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1886-87.



BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET.
(PRINTERS TO THE QUEEN'S COLLEGE.)

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# Belfast Natural History and Philosophical Society.

ESTABLISHED 1821.

## SHAREHOLDERS.

1 Share in the Society costs £7.
2 Shares ,, ,, cost £14.
3 Shares ,, ,, cost £21.

The Proprietor of 1 Share pays 10s. per annum; the proprietor of 2 Shares pays 5s. per annum; the proprietor of three or more Shares stands exempt from further payment.

Shareholders only are eligible for election on the Council of Management.

## MEMBERS.

There are two classes, Ordinary Members, who are expected to read Papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read Papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due first November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto; also of access to the Museum for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

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The Museum, College Square North, is open daily from 12 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

BELFAST

# Natural History and Philosophical Society.

## ANNUAL REPORT, 1886

The Annual Meeting of the Shareholders in this Society was held on June 17th, 1887, in the Museum, College Square North. Mr. W. H. Patterson, *President*, occupied the chair. There were also present:—Messrs. R. M. Young, R. L. Patterson, J.P.; James Henderson, J. J. Murphy, R. Young, John Greenhill, E. F. Patterson, Joseph Wright, William Gray, William Swanston, James Meharg, Thomas Workman, James Thompson, J.P.; and James Wilson.

Mr. R. M. Young, *Hon. Secretary*, read the notice convening the meeting. He also read the Annual Report of the Council, which stated:—

"The Council of the Belfast Natural History and Philosophical Society appointed by the Shareholders at their Annual Meeting on June 3rd, 1886, desire to submit their Report of the working of the Society during the past year.

"The Winter Session was opened on November 2nd, 1886, with an address from your President, Mr. W. H. Patterson, M.R.I A., the subject selected being "Some Later Views respecting the Irish Round Towers." The second meeting was held on December 7th, 1886, when Mr. Thomas Workman, J.P., read a paper on "Eastern Reminiscences: China and Manilla." The lecture was illustrated by a fine series of photographic and lantern views. The third meeting was held on January 4th, 1887, when Mr. A. B. Wilson gave a paper on "Power." The Rev. Canon Grainger, D.D., M.R.I.A., read a short paper entitled "A Question on the Antrim Gravels," illustrated by a

collection of Irish and other antiquities. The fourth meeting was held on February 1st, 1887, when Mr. Seaton F. Milligan read a valuable paper on "Recent Archæological Explorations in the County Sligo," illustrated by a series of lime-light views, maps, and antiquities. The fifth meeting was held on March 1st, 1887, when Mr. William Gray read a paper on "Technical Education, and our Methods of Promoting it." The sixth meeting was held on March 9th, 1887, when Mr. W. H. Hartland, R.E.C.E., gave a paper on "Sewage Disposal and River Pollutions; its present and future aspect from a sanitary and economical point of view," illustrated by practical experiments upon the treatment of sewage. The seventh meeting was held on April 5th, 1887, when Mr. R. Lloyd Patterson, J.P., F.L.S., read a paper entitled "Some Account of the Whale and Seal Fisheries, past and present;" and Mr. Conway Scott, B.E., another on "Epidemic Diseases: Can they be stamped out?"

"In addition to these ordinary meetings, your Council made arrangements to continue the special series of Popular Scientific Lectures, similar to those given in former years. These have been very well attended, both by the Members of the Society (who were admitted free) and by the general public. They have also proved successful pecuniarily. This satisfactory result must be attributed to the kindness of the lecturers, who so generously placed their services at the disposal of your Council. The first of these special meetings was held on December 10th, 1886, in the Young Men's Christian Association Hall, Wellington Place, when Mr. Henry Seebohm, F.L.S., London, gave a lecture on his "Adventures in Siberia." At the special request of the Council, Mr. Seebohm kindly consented to give a second lecture, subject "The Migration of Birds," in the same hall on December 13th, 1886. The third meeting was held on February 2nd, 1887, in the Ulster Minor Hall, when Mr. W. J. Finlayson, of Johnstone, Renfrewshire, gave a lecture on "Photography," illustrated by a large number of fine photographic views taken by himself. The fourth meeting was held on February 23rd, 1887, in the Ulster Minor Hall, when the Rev. W. S.

Green, M.A., delivered a lecture on "A Dredging Cruise in the Atlantic," illustrated by a large number of original lantern slides. The concluding meeting of the series was held on March 17th, 1887, in the Ulster Minor Hall, when Professor E. A. Letts, Ph.D., gave a lecture on "Fermentation and Kindred Phenomena," fully illustrated. Mr. James Meneely, Belfast, kindly lent his powerful lantern and his services for both Mr. Finlayson's and the Rev. Mr. Green's lectures.

"The financial condition of the Society, as may be seen from the Treasurer's report, continues to show steady improvement. Your Council have let the room known as the Library to the Ulster Medical Society for one year, from 1st November, 1886, reserving due access to the books for the Society's members at all times. The number of smaller societies holding their meetings in the Museum show no signs of decrease. The considerable balance now carried forward will, no doubt, enable the Council of next year to carry out the various much-needed improvements so often deferred for want of funds.

"A list of donations to the Museum, and of publications from the various leading Philosophical and Scientific Societies throughout the world, is printed with the present Report. The Council desire to thank the various donors for their valuable gifts, and particularly Captain Robert Campbell, of the ship "Slieve Donard," who has again supplemented his previous generous donations by presenting a number of rare East Indian fishes and butterflies.

"Your Council arranged this year to have the Museum opened on Easter Saturday and Tuesday, in addition to Easter Monday, at a nominal charge. Some friends, including the Ulster Amateur Photographic Society, Messrs. J. Browne, J. M. M'Gee, and T. F. Shillington, lent valuable exhibits, which had the effect of increasing very considerably the number of visitors and the receipts.

"The ceilings of some of the rooms have been thoroughly repaired. A new book-case has been added to the library. The Librarian has had the books carefully catalogued for some time, and your Council would suggest the advisability of having the

catalogue printed, so as to bring the books more under the notice of the scientific public. A more pressing requirement, however, is the question of printing the catalogue of Irish antiquities, which would add very much to the interest of the fine collection in the possession of your Society."

The Chairman, in the absence of Mr. Brown, Hon. Treasurer, read the financial statement, which showed a balance in favour of the Society of £62 9s. 2d.

Mr. Henderson said he had great pleasure in moving the adoption of the Report read by their Secretary, and also of the Treasurer's statement of accounts. He was very much gratified at the Report, and he thought they had reason to congratulate themselves individually, and Mr. Young, their Secretary, in particular, on the very large number of lectures that were delivered during the past year, on their varied character, and their general excellence. He must ask the members to receive his apology for not coming far oftener to those lectures; but really when one has two or three meetings to attend in a week, to come to a fourth is a little too much, and he found it utterly impossible to attend more than once a month. He had been present at two of the lectures during the year, and there were some present who could support him when he said that they were well delivered and most interesting; while the subjects discussed were calculated to benefit all who were of an inquiring turn of mind. Mr. Young, their Secretary, was kind enough to invite him (Mr. Henderson) to deliver a lecture on his trip to America; but he asked Mr. Young to excuse him from doing so, as he hoped to go back and visit that wonderful part of the country towards San Francisco. He thought the two together would make a better lecture than merely half the journey. The Treasurer's statement was exceedingly satisfactory. It quite surprised him to find an institution of that kind having a balance of £62 odd. He trusted that those much-needed improvements, which it was not necessary to enumerate, would be successfully carried out, and that at next year's meeting they would be able to congratulate the members on the improved appearance of the

building. He had much pleasure in moving the adoption of the Reports.

Mr. William Gray, in seconding the motion, said he could heartily endorse what had been said with reference to the value of the papers brought before the Society itself, as well as the special lectures. Indeed, the Society deserved the thanks of the public for having enabled them to hear special lecturers of great ability. The ordinary papers were interesting to the members of the Association, but the special lectures were of great value to the general public. Those delivered during the year were exceedingly interesting. It was rather unfortunate that they were obliged to change the place in which those lectures were delivered, but he hoped it would not be long until they would have an appropriate room provided by the town. They had been very successful in providing a place for kindred societies, such as the Naturalists' Field Club, who had been long entertained in that establishment, as well as the Photographic Society and the Medical Society. He believed they were carrying out the views of the original promoters in giving every facility to kindred societies to carry on their operations.

Mr. Robert Lloyd Patterson stated that he very cordially and warmly agreed with what had fallen from Mr. Gray with regard to the advantage derived by the Society, and the instruction given to the public by means of the series of scientific lectures which had been delivered during the year. The fact of the lectures being public gave persons not connected with that Society an opportunity of hearing some of the best-known men on different departments of science. He returned his sincere thanks to Mr. Seebohm, of London, who had delivered two lectures in Belfast ; and he wished to take that opportunity of saying that he saw Mr. Seebohm in London last week, and told him that they looked with great pleasure on his recent visit to this town. Mr. Seebohm said it was his intention to pay a visit to Africa, and get more information about his favourite subject—the migration of birds. He (Mr. Patterson) requested Mr. Seebohm to pay Belfast another visit, and although he did not say definitely that he would accede to

the request, he did not say that he would not come. Mr. Seebohm told him that he looked back with feelings of pleasure on his late visit to Belfast, and said he was sure he would experience the same pleasure if he came amongst them again.

The Report and statement of accounts were adopted.

### PRESENTATION OF A PORTRAIT.

At the conclusion of the Annual Meeting the members met in the lower room for the purpose of receiving from Mr. Richard Hooke a portrait which he had painted of the late Mr. James Macadam, a former President of the Society.

Mr. Joseph John Murphy, who presided, explained the purpose for which they were met. The late Mr. James Macadam was one of the founders of that Society, and he was a gentleman to whom that Museum owed much. At the fiftieth anniversary of the Society Mr. R. L. Patterson gave an interesting account of its history, and among the names of the seven original members was that of Mr. James Macadam, whose portrait had been painted by Mr. Hooke, who was now about to present it. The late Mr. Macadam continued a member up to his death, in 1861. He was one of the best of our geologists, and had a great knowledge of local geology. He contributed many valuable specimens to that Museum. The Chairman then called upon the artist to present the portrait.

Mr. Richard Hooke, who was well received, said when he first thought of presenting that small gift to the Society he had not the slightest expectation that he should be prominent in the matter. He was anxious to secure for the portrait a favourable position in the light, which was very willingly granted. However, when their courteous and energetic Secretary intimated that there was a desire that he should personally present the portrait, he felt very happy at being able to come and meet some of the distinguished members of that Society. It was not necessary that he should say more than that he felt very happy at having it in his power to make the presentation of a portrait of one of their most eminent men. He had been employed a quarter of a century ago by the present Mr. Robert

Macadam to paint some portraits of his family, and a small photograph of the subject of the painting was given to him to enlarge. He made that a specimen portrait, which was a necessary thing for all artists to have. It was hung at the Manchester Exhibitions, and he dare say had he sent it to London it would have been given a place in the Academy. The style was rather out of fashion, and that made it suitable for a museum. The date of the painting was 1863, and it was now as fresh and bright as it was when painted.

Mr. W. H. Patterson stated that, as the late President, he had the pleasure of accepting the portrait on behalf of the Society, and of thanking Mr. Hooke most warmly for having presented it. Not only had the picture expression, but it gave an idea of the late Mr. Macadam's size, which portraits very often did not do. He moved that the best thanks of the Society be awarded to Mr. Hooke for his kindness in presenting the Society with that fine portrait of their former President, Mr. James Macadam.

Mr. Robert Young seconded the resolution, and said he had great pleasure in doing so. He had been very intimate with the late Mr. James Macadam from the time when he was at the Belfast Academy. He was a very distinguished geologist, and one who had taken great interest in that Society. The portrait was a most admirable one, and he thought Mr. Hooke was entitled to their warmest thanks He hoped that was only the beginning of a series of portraits that they should have. They ought to have portraits of their past Presidents.

Dr. S. Browne said he had much pleasure in accepting the invitation to be present. He was a very intimate friend of the late Mr. James Macadam, and he could say that the portrait was a very true one. He had just had the pleasure of seeing a portrait of Sir David Taylor, painted by Mr. Hooke, and it was a most admirable likeness. He (Dr. Browne) was glad to be present, and to have the opportunity of seeing that portrait of one who had been an intimate and valued friend.

Mr. R. L. Patterson remarked that he had known Mr. Macadam from his (Mr. Patterson's) earliest boyhood, and

although twenty-six years had elapsed since he was removed from amongst them, he had a distinct recollection of his former face, of which that portrait was a most admirable representation. He thought Mr. Hooke had made a good beginning by presenting to the Society that picture, and it was their sincere wish that they should shortly see the portraits of former Presidents of the Society adorning the walls of that Museum.

The resolution was unanimously passed, and

The meeting concluded.

*The Belfast Natural History and Philosophical Society, in account with Treasurer, for Year ending 1st May, 1887.*

**Dr.** **Cr.**

### EXPENDITURE.

| | £ | s. | d. |
|---|---|---|---|
| To Cash paid Insurance Premiums ... ... | £9 | 11 | 3 |
| ,, ,, Printing Report ... ... | 7 | 9 | 0 |
| ,, ,, Advertising ... ... ... | 11 | 16 | 5 |
| ,, ,, Printing and Stationery ... | 7 | 5 | 5 |
| ,, ,, Water Rate ... ... ... | 2 | 4 | 7 |
| ,, ,, Repairs to Ceilings, etc. ... | 21 | 12 | 4 |
| ,, ,, Postage and other Stamps ... | 4 | 2 | 6 |
| ,, ,, New Book Case ... ... | 4 | 0 | 0 |
| ,, ,, Collector's Commission ... | 6 | 11 | 2 |
| ,, ,, Expenses at Easter ... ... | 11 | 0 | 6 |
| ,, ,, Wm. Darragh, Salary till 1st May | 48 | 0 | 0 |
| ,, ,, S. A. Stewart, Salary till 1st May, less four months' leave ... | 33 | 6 | 8 |
| ,, ,, Rent till 1st May ... ... | 25 | 0 | 0 |
| ,, ,, Fuel and Gas ... ... | 13 | 9 | 4 |
| ,, ,, Small Accounts ... ... | 4 | 6 | 10 |
| To Balance ... ... .. ... | 62 | 9 | 2 |
| | £272 | 5 | 2 |

### RECEIPTS.

| | £ | s. | d. |
|---|---|---|---|
| By Balance in hand ... ... ... | £33 | 4 | 0 |
| ,, Interest on Loan to York Street Spinning Company ... ... ... | 19 | 6 | 9 |
| ,, Contribution from Ulster Medical Soc., 1885-6 | 6 | 0 | 0 |
| ,, ,, ,, 1886-7 | 29 | 4 | 0 |
| ,, ,, Engineers' Assoc.—Arrears | 4 | 3 | 0 |
| ,, ,, Naturalists' Field Club ... | 5 | 5 | 0 |
| ,, ,, Bee-Keepers' Association | 1 | 11 | 6 |
| ,, ,, Ulster Amateur Photographic Society ... ... | 3 | 13 | 6 |
| ,, Proceeds of Popular Lectures ... ... | 10 | 8 | 6 |
| ,, Donations ... ... ... ... | 8 | 0 | 0 |
| ,, Transfer Fees ... ... ... ... | 0 | 15 | 6 |
| ,, Subscriptions ... ... ... ... | 91 | 2 | 0 |
| ,, Do. in arrear ... ... ... | 7 | 0 | 0 |
| ,, Entrance Fees at Door till 30th April ... | 16 | 14 | 9 |
| ,, Do. do. at Easter ... | 35 | 16 | 8 |
| | £272 | 5 | 2 |
| By Balance ... ... ... ... | 62 | 9 | 2 |

Examined and found correct,
*June* 2, 1887.

WM. H. PATTERSON, } *Auditors.*
SAMUEL ANDREWS, }

J. BROWN, *Hon. Treasurer.*

## DONATIONS TO THE MUSEUM, 1886-87.

*From* Mr. Charles Bulla.

A number of fossil fish remains from the Carboniferous rocks of Armagh.

*From* Capt. Robert Campbell, Master of the Ship "Slieve Donard."

One case of Indian insects (*Lepidoptera* and *Coleoptera*), one cuttle-fish (*Loligo*), one head of sword-fish (*Istiophorus indicus*), two globe fish (*Tetravdon*), one porcupine fish (*Diodon*), three sea-horses (*Hippocampus*), one cow-fish (*Ostracion*), one hornet fish.

*From* Mr. William Darragh.

One stuffed specimen of the velvet scoter (*Oidemia fusca*), shot in Belfast Bay.

*From* Mr. J. T. Erskine, Jordanstown.

One skin of python, from Brazil.

*From* Rev. Canon Grainger, D.D., M.R.I.A.

A collection of fossils, chiefly from the Carboniferous rocks of Kildare.

*From* Professor Haddon, F.L.S., Dublin.

Several rare sea-urchins, and star-fish dredged off the southwest coast of Ireland.

*From* Dr. H. W. Luther.

One large flying fish.

*From*. J. G. Robertson, Esq., Kilkenny.

Cast of a bronze hatchet, and cast of a portion of the mouldings of St. Canice, Kilkenny.

*From* Mr. S. A. Stewart.

Two stone implements found on the sandhills at Ballykinler, Co. Down.

*From* Thomas Workman, Esq., J.P.

Eight bottles of land and marine animals, preserved in spirits.

*From* Messrs. Fitzpatrick.

Plated disc with engraved crest.

## LIST OF BOOKS RECEIVED DURING THE YEAR.

ADELAIDE.—Transactions, Proceedings, and Report of the Royal Society of South Australia. Vol 8, 1886. *The Society.*

BELFAST.—Proceedings of Belfast Naturalists' Field Club. Series 2, vol. 2, no. 6, 1886 *The Club.*

Belfast Society for Promoting Knowledge. Early Belfast Printed Books, List no. 1 *The Society.*

BERLIN.—Verhandlungen der Gesellschaft fur Erdkunde. Vol. 13, nos. 5—10, 1886; and vol. 14, no. 1, 1887. *The Society.*

BOSTON.—Proceedings of Boston Society of Natural History. Vol. 23, part 2, 1886. *The Society.*

BREMEN.—Abhandlungen vom Naturwissenschaftlichen Vereine. Vol. 9, part 4, 1887. *The Society.*

BRESLAU.—Zeitschrift fur Entomologie. New series, part 11, 1886. *The Society.*

BRIGHTON.—Annual Report of the Brighton and Sussex Natural History Society, 1885-6. *The Society.*

BROOKVILLE.—Bulletin of the Brookville (Indiana) Society of Natural History, no. 2, 1886. *The Society.*

BRUSSELLS—Annales de la Société Royale Malacologique de Belgique. Vol. 20, 1885.

Bulletin de la Société Royale de Botanique de Belgique. Vol. 25, parts 1 and 2, 1886. *The Society.*

Comptes Rendu de la Société Entomologique de Belgique. Series 3, nos. 72-81. *The Society*

BUENOS AYRES.—Boletin de la Academia Nacional de Ciencias. Vol 8, part 4, 1885. *The Academy.*

CALCUTTA.—Memoirs of the Geological Survey of India (Palæontologia Indica). Series 10, vol 4, parts 1 and 2, series 12, vol. 4, part 2; series 13, nos. 1 and 6; series 14, vol. 1, fasc. 6, 1886.

Records, vol. 19, part 4, 1886; vol. 20, part 1, 1887.
Catalogue, 3 parts, 1885 and 1886. *The Survey.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 12, nos. 5 and 6; vol, 13, nos. 1 and 3. Annual Report of the Curator, 1885-6. *The Museum.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 17, 1885.
Flora of Cardiff, 1886. *The Society.*

CASSELL.—Bericht des Vereines fur Naturkunde zu Cassell, parts 31—33, 1884-6.
Festschrift des Vereines fur Naturkunde. *The Society.*

CHRISTIANA.—Forhandlinger i Videnskabs Selskabet, 1886. *The Society.*

DANTZIC.—Schriften der Naturforshendon Gesellschaft, new series. Vol. 6, part 4, 1887. *The Society.*

DAVENPORT, U.S.A.—Proceedings of the Davenport (Iowa) Academy of Natural Sciences. Vol. 4, 1882-4. *The Academy.*

EDINBURGH.—Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 16, part 3, 1886. *The Society.*

Proceedings of the Royal Physical Society, Session 1885-1886. *The Society.*

Astronomical Observations of the Royal Observatory, being Vol. 15, for 1878 to 1886 (Star Catalogue, Discussion, an Ephemeris). *The Observatory.*

ESSEX.—Transactions of the Essex Field Club. Vol. 4, part 2, 1886, and Essex Naturalist, Nos. 1—4, 1887. *The Club.*

FLORENCE.—Bulletino della Societa Entomologica Italiana. Trimestri 1—4, 1886, and 1—2, 1887. *The Society.*

FRANKFORT.—Naturwissenschaftlichen Vereines des Reg. Bez. Vol. 4, No. 12, 1886–7. *The Society.*

GENOA.—Giornale della Societa di Letture e Conversazioni Scientifiche di Genoa, anno 9, 1 semestre, fasc. 3—5, 2 semestre, fasc. 7, 8, 9, 11, 12, 1886-7. *The Society.*

GIESSEN.—Oberhessischen Gesellschaft fur Natur-and Heilkunde, 1886. *The Society.*

GLASGOW. — Proceedings of the Philosophical Society of Glasgow, Vol. 17, 1885-6. *The Society.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaftlichen herausgegeben vom Naturwissenschaftlichen Verein, Vol. 9, parts 1 and 2, 1886. *The Society.*

KIEW.—Memoirs of the Naturalists' Society. Vol. 8, part 2. *The Society.*

LAUSANNE.—Bulletin de la Societe Vaudoise des Sciences Naturelles. Ser. 3, vol. 22, No. 24, 1886. *The Society.*

LEIPSIC.—Mitheilungen des Vereins fur Erkkunde zu Leipzig, 1884 and 1885. *The Society.*

Sitzungsberichte der Naturforschendon Gesellschaft, 12th year, 1886. *The Society.*

LIVERPOOL.—Proceedings of the Literary and Philosophical Society. Vol. 39, 1885, and vol. 40, 1886. *The Society.*

LONDON.—Cooke's Illustrations of British Fungi. Nos. 42-48. *Lord Clermont.*

Theory of Voltaic Action. J. Brown (Proc. Roy. Soc.). *The Author.*

Journal of the Royal Microscopical Society. Series 2, vol. 6, parts 3—6, and 6a, 1886. Parts 1 and 2, 1887. *The Society.*

Walford's Antiquarian. Vol. 2, no. 63, 1887. *The Publishers.*

Proceedings of the Zoological Society. Parts 1-4, 1886. *The Society.*

Journal of Hydrotherapeutics. Vol. 1, no. 1, 1887. *The Publishers.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol. 18, part 20, and vol. 19, parts 1-7, 1886-7. *The Society.*

MOSCOW.—Bulletin de la Société Imperiale des Naturalistes. No. 4, 1886; and no. 1, 1887, also
Meteorologische Beobachtungen, 1886. *The Society.*

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 3, nos. 9—12, 1885, and
Transactions of the New York Academy of Sciences. Vol. 5, nos. 2—8, 1885-6. *The Academy.*
Bulletin of the American Geographical Society. No. 6, 1882; no. 7, 1883; no. 5, 1884; nos. 3—5, 1885; nos. 1—3, 1886. *The Society.*

ODESSA.—Memoirs of the New Russian Society of Naturalists. Vol. 10, parts 1 and 2, 1885-6. Vol. 2, parts 1 and 2, 1886-7, also
Appendix to vol. 10 of Memoirs. *The Society.*

PADUA.—Atti della Societa Veneto-Trentino di Scienze Naturali. Vol. 10, fasc. 1, 1887; and
Bulletino. Vol. 3, no. 4. *The Society.*

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences. Part 3, 1885; and parts 1—3, 1886. *The Academy.*

PISA.—Atti della Societa di Scienze Naturali, Processa Verbali. Vol. 5, pp. 80—170, and 203—226. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Series 4, vol. 2, fasc. 1 and 2, and 5—14, 1886; and vol. 3, fasc. 1—7, 1887. *The Academy.*
Journal of the British and American Archæological Society of Rome. Vol. 1, no. 1, 1886 *The Society.*

SAN FRANCISCO—Bulletin of the California Academy of Sciences, Vol. 1, No. 4, and Vol. 2, No. 5, 1886. *The Academy.*

SONDERHAUSEN.—Irmischia. Nos. 1—8, 1886. *The Society.*

TORONTO.—Proceedings of the Canadian Institute. Ser. 3, Vol. 3, fasc. 4; Vol. 4, fasc. 1, 1886, and fasc. 2, 1887. *The Institute.*

TRENTON, N.J.—Journal of the Natural History Society. Vol. 1, no. 1, 1886. *The Society.*

TRIESTE.—Bolletino della Societa Adriactica di Scienze Naturali. Vol. 9, nos. 1 and 2, 1885 and 1886. *The Society.*

VENICE.—Notarisia Commentarium Phycologium, no. 5, 1887. *The Society.*

VIENNA.—Verhandlungen der Kaiserlich Koniglichen Geologischen Reichsanstalt. Nos. 7—18, 1886, and 1—4, 1887. *The Society.*

Verhandlungen der Kaiserlich Koniglichen Zoologisch-botanischen Gessellschaft. Vol. 36, parts 1—6, 1886-7. *The Society.*

WARWICK.—Proceedings of the Warwickshire Naturalists' and Archæologists' Field Club, 1885. *The Club.*

WASHINGTON.—Report of the Department of Agriculture, 1885. *The Department.*

Annual Report of the Smithsonian Institution, parts 1 and 2, 1884. *The Institution.*

Third Annual Report of the Geological Survey of the United States, 1881-2. *The Survey.*

## BELFAST

# NATURAL HISTORY & PHILOSOPHICAL SOCIETY,

## SESSION 1886—87.

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*2nd November*, 1886.

The President, William H. Patterson, Esq., M.R.I.A., gave an Address on

## SOME LATER VIEWS RESPECTING THE IRISH ROUND TOWERS.

The President traced briefly the position of the round tower controversy up to the period at which Dr. Petrie published his essay. Dr. Petrie's arguments were then reviewed, as were the subsequent writings on the same subject of Sir William Wilde, Mr. Marcus Keane, and Mr. Henry O'Neill. Having referred to the magnificent volumes of Lord Dunraven dealing with the subject, the President directed attention to the more recent writings of Miss Margaret Stokes. He proceeded—In 1878 Miss Margaret Stokes published her "Early Christian Architecture in Ireland." With this work was incorporated some of the matter which Miss Stokes had already given to the world in the concluding portion of Lord Dunraven's book. Miss Stokes holds that the first round towers were erected in Ireland soon after the first invasions of the Northmen for the protection of the religious communities against these Pagan invaders, and that the erection of these church keeps or castles continued for about three centuries—that is, from a little before the year A.D. 900 to about A.D. 1200. In speaking of the state of architecture in Ireland at the close of the ninth century, Miss Stokes says that, although the use of cement and the hammer was known to Irish builders, the horizontal lintel had not yet been superseded by the arch, and at this point we arrive at a class of

buildings which forms a striking innovation in the hitherto humble character of Irish church architecture—that is, the lofty pillar tower. In the beginning of the present century the existence of 118 of these circular ecclesiastical towers was asserted ; of these seventy-six remain to the present time in a more or less perfect condition. Miss Stokes remarks that a certain development of knowledge and skill in the art of building may be traced in these various examples, and that such changes are analogous to those which took place in the church architecture of Ireland after the eighth century. She then attempts a rough classification of the existing round towers, showing the gradation in masonry and the corresponding changes in the character of the door and window opes. There are four divisions into which the towers are classified. First style—Rough field stones, untouched by hammer or chisel, not rounded, but fitted by their length to the curve of the wall, roughly coursed, wide-jointed, with spalds or small stones fitted into the interstices. Mortar of coarse unsifted sand or gravel. Second style—Stones roughly hammer-dressed ; rounded to the curve of the wall ; decidedly, though somewhat irregularly, coursed. Spalds, but often badly bonded together. Mortar freely used. Third style—Stones laid in horizontal courses, well dressed, and carefully worked to the round and batter ; the whole cemented in strong plain mortar of lime and sand. Fourth style—Strong, rough, but excellent ashlar masonry, rather open-jointed, and therefore closely analogous to the English-Norman masonry of the first half of the twelfth century ; or, in some instances, finest possible examples of well-dressed ashlar. Sandstone in squared courses. Miss Stokes then follows with what she calls a broad classification of the towers according to the average styles of their masonry and apertures. Those which belong to the first style of masonry have doorways of the same material as the rest of the building ; sometimes the stones are roughly dressed ; the door-opes are square-headed, with inclined sides ; about 5ft. 6in. high by 2ft. wide, and 8ft. to 13ft. above the level of the ground. In the second and third styles of masonry there will be found in the

doorways the first idea of an arch, the curve being scooped out of three or five stones; the stones of the doorways are generally of some finer material than the rest of the wall, and sometimes an architrave or moulding is introduced. In the fourth style we find the doorways formed with a regular radiating arch of six or more stones, with architrave, or fine examples of the decorated Irish Romanesque of the twelfth century. Miss Stokes considers that the following conclusions may be drawn from those comparisons:—1. That these towers were built after the Irish became acquainted with the use of cement and the hammer. 2. That the towers were built at or about the period of transition from the entablature style of the early Irish period to the round-arched decorated Irish-Romanesque style. 3. That the largest number of these towers were built before this transition had been established, and while the Irish builders were feeling their way to the arch. 4. That as this transition took place between the time of Cormac O'Killen and Brian Borumha—*i.e.*, between A.D. 900 and 1000—the first groups of towers belong to the first date. The average thickness of the wall at the base of the towers is from 3ft. 6in. to 4ft. The usual diameter at the level of the doorway is from 7ft. to 9ft. internally. The towers taper, and their walls diminish in thickness towards the top. In height the towers vary from about 50ft. to over 100ft. Internally the towers were divided into six or seven storeys. The floors, which were of wood, were supported in one of three different ways. The beams either rested on projecting abutments in the wall, or there were holes for the joists; or, thirdly, corbels or brackets supported the floors. The height of the doorway above ground averages 13ft., but it varies considerably. The doorways always face the entrance of the church to which they belong, unless in those instances where the church is evidently much later than the tower, and it is found that the position of the tower was usually about 20ft. distant from the north-west corner of the church. The name by which these towers are usually distinguished by the writers of the Irish annals is "cloicthech," signifying bell-house or belfry. There are numerous references in the annals

of disasters to these belfries by fire, lightning, and other causes. We also learn that persons took refuge in these towers, and that sometimes the protection of the towers was sought in vain. We can picture to ourselves the attacking party breaking in the narrow door, even though fourteen or fifteen feet from the ground, and introducing fire, which burned up the successive wooden lofts, with the unfortunates who had crowded in for refuge. We also find that the guardians of the church used the tower as the safest place they had for the keeping of their sacred utensils, relics of saints, manuscripts, croziers, and bells. It is evident that the towers have suffered very much from the effects of lightning. The old annalists have told us this, and even in modern times several of the towers have been greatly injured by lightning. This is not surprising. The only wonder is, considering the length of time they have stood stretching towards the clouds, that they have not suffered very much more than they have done. The tall shaft of masonry and pointed roof must offer a very dangerous attraction to the electric current. Probably our moist climate and consequent comparative immunity from severe thunderstorms may have helped to preserve so many of our round towers in a very perfect condition. Dr. Petrie cites a passage from Colonel Montmorency's writings showing his idea as to the impregnable nature of the tall circular tower. We have seen by the extracts from our annals that in some cases the tower was not absolutely impregnable. He writes—"The pillar tower as a defensive hold, taking into account the period that produced it, may fairly pass for one of the completest inventions that can well be imagined. Impregnable every way, and proof against fire, it could never be taken by assault. Although the abbey and its dependencies blazed around, the tower disregarded the fury of the flames. Its extreme height, its isolated position, and diminutive doorway, elevated so many feet above the ground, placed it beyond the reach of a destroyer. The signal once made announcing the approach of a foe by those who kept watch at the top, the alarm spread instantaneously, not only among the inmates of the cloister, but the inhabitants were roused to arms in the

country for many miles around." Sir Walter Scott writes :—"These towers might possibly have been contrived for the temporary retreat of the priests, and the means of protecting the holy things from destruction on the occasion of alarm, which in those uncertain times suddenly happened and as suddenly passed away." And to this Miss Stokes adds :—"Consisting of a series of small chambers, one above the other, at a height above ground, they were fitted for places of storage for the sacred things of the church, places of passive defence for the aged and weak, and could afford temporary shelter for from forty to eighty persons from the attacks of an enemy only armed with bows and arrows, and such weapons as we know were in use at the time in the North-West of Europe." After a very full and careful survey of all the matters connected with this subject, Miss Stokes writes :—"The conclusion drawn from all these data being that such towers, though constructed from time to time over a considerable period, and undergoing corresponding changes in detail, were first built at the close of the ninth century, and that a number seem to have been erected simultaneously ;" and again, in speaking of the first arrivals of Danish invaders in this country—"In the beginning of the ninth century a new state of things was ushered in, and a change took place in the hitherto unmolested condition of the Church. Ireland became the battlefield of the first struggle between Paganism and Christianity in Western Europe, and the result of the effort then made in defence of her faith is marked in the ecclesiastical architecture of the country by the apparently simultaneous erection of a number of lofty towers, rising in strength of 'defence and faithfulness' before the doorways of those churches most likely to be attacked. The first descent of the Northmen upon Ireland was in 795, when a party of them sailed across from Wales and plundered the church on the Island of Lambay, near Dublin. The Welsh annals record that the black pagans first came to the Island of Britain from Denmark, and made great ravages in England. Afterwards they entered Glamorgan, and there killed and burnt much ; but at last the Cymry conquered them, driving

them into the sea. From thence they went to Ireland, and devastated Recheryn and other places. Three years afterwards, according to O'Flaherty's chronology—*i.e.*, in 798—they plundered the Isle of Man and the Hebrides. In 802 they burned Iona, and again in 806 plundered the same island, but not without resistance, for sixty-eight of the monastic society of the island were slain. The following year, 807, they entered for the first time the mainland of the West and South of Ireland, and, having plundered the Island of Inishmurry, off the coast of Sligo, they advanced inland as far as Roscommon. In 812 and 813 we find them in Connaught and Munster, where they suffered more than one defeat from the native chieftains. Finally, in 815, or, according to other accounts, in 830, a Norwegian leader called by the Irish writers Thorgils, which name was Latinised Turgesius, established himself as sovereign of the foreigners, and made Armagh the capital of his kingdom. For the purpose of strengthening his position, he placed detachments of his forces at Limerick, at Lough Ree, on the Shannon; at Dundalk Bay, Carlingford, Lough Neagh, and Dublin. For four years Thorgils was able to maintain himself at Armagh, and during this time, by taking command of his fleet on Lough Ree, he plundered all the great ecclesiastical establishments upon the banks of the Shannon, and, having seized the Abbey of Clonmacnoise, and burnt its oratories, he left his wife as sovereign there. This lady's name was Ota, and, according to the ancient record, she gave her audiences, or answers, from the high altar of the principal church of the monastery. During this time, and afterwards, reinforcements continued to reach the Scandinavians in Ireland from their own country." About 837 a fleet of sixty-five ships landed at Dublin, and a few years later an Irish scribe wrote that there was not a point in Ireland without a fleet, and that the sea seemed to vomit forth floods of invaders. From this time on for about two centuries we hear of continued invasions of the Northmen, and there seems to have been no part of the country into which their marauding bands did not pass. The monasteries, being the receptacles of most of the wealth of the country, were

constantly visited and plundered by them. The two nations of Northmen are represented as hostile to each other, and battles between them took place frequently in Irish waters or on the mainland. But these feuds did not interfere with their main object, which was the persistent plundering of the country, and the carrying away as slaves of thousands of men, women, and children. We find that Armagh was plundered by the Danes in seventeen different years from A.D. 832 to 1016, and it was attacked three times in one month. The church of Maghera was attacked three times in one month. Clonard, the seat of one of the great schools in Ireland, was invaded seven times from 838 to 1020. Before the year 900 the Norsemen had first ravaged the coast and the outlying islands, and then their boats were repeatedly seen on the Boyne, the Liffey, and the Shannon. In the valleys of these rivers distinct groups of these towers and churches are to be seen that had been for the first seventy years of this war attacked and desecrated with such fury. After reviewing some historical records as to the building of certain towers and peculiarities in their construction, Miss Stokes writes :—" Thus we find three distinct periods to which these towers may be assigned—first, from A.D. 890 to 927 ; secondly, from 973 to 1013 ; thirdly, from 1178 to 1238 ; and of these three periods the first two were marked by a cessation of hostilities with the Northmen, while the Irish made energetic efforts to repair the mischief caused by the invasions of the heathen. It is clear that these three divisions are distinctly marked by three steps in the progressive ascent of architecture, from the primitive form of the entablature to that of the decorated Romanesque arch. The churches built by Cormac O'Killen are characterised by the horizontal lintel ; the church of King Brian, at Iniscaltra, with its still partially developed Romanesque doorway and chancel arch, while retaining the rude form in its minor apertures, marks a period of transition from the horizontal to the round arched style ; and the buildings of Queen Dervorgilla and Turlough O'Connor, with the doorway of Clonfert, show what the latter style became in the lifetime of Donough O'Carroll. If Lusk, Glen-

dalough, Timahoe, and Ardmore are taken as types of this gradation in the towers, we see such signs of progress as lead to the belief that a certain interval of time had intervened between the first and last mentioned of those erections." Miss Stokes concludes one portion of her work in the following words :— "There is, perhaps, no question of early Christian archæology," writes Mr. Fergusson, "involved in such obscurity as that of the introduction and use of towers." The difficulty of clearing away such obscurities has arisen chiefly from the want of monuments remaining on the Continent to show what were the earliest types in Western Europe. The light that Ireland might cast upon the subject has not yet made itself felt, because of the uncertainty that has too long lingered about the history of her towers. Dr. Petrie, by his investigations, brought their date down from a pre-Christian time to a period ranging from the sixth to the thirteenth century, and firmly established their ecclesiastical character. Lord Dunraven traced the type from Ireland, through France to Ravenna, thereby proving it analogous to that of buildings belonging to an historic period elsewhere. But he felt that the area was far too wide over which Dr. Petrie had extended the practice of erecting these structures, and was gradually arriving at the conclusion that such masonry as they exhibit was not to be found in Ireland before the ninth or tenth century, and that her decorated Romanesque churches belong to the eleventh and twelfth. Starting from the standpoint of these two archæologists, we may arrive at conclusions which give to these towers their true place in history. From these noble monuments the historian of Christian art and architecture may learn something of the work of a time the remains of which have been swept away elsewhere, and it may yet be seen, as in the case of her institutions, customs, faith, and forms in art, so in architecture, Ireland points to origins of noble things.

*7th December*, 1886.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Thomas Workman, Esq., J.P., read a Paper on

## EASTERN REMINISCENCES, CHINA AND MANILLA.

Mr. Workman remarked that when last before them his reminiscences were of India and Burmah. He would now proceed still further to the East. He would try to enable them to realise what the world is like almost as far round as the antipodes, and possibly beyond, where Shakspere thought of when he said, "One touch of nature makes the whole world kin," though he was somewhat inclined to add, in the words of a more recent poet, "Where every prospect pleases and only man is vile." In January, 1884, he entered the beautiful Bay of Manilla, and he could well sympathise with the expressions of joy and pride with which his Spanish fellow-travellers greeted "Les Philipines," as they called the Philipine Islands. It is a most lovely sight, and the entrance is exceedingly narrow, though the bay opens into an enormous sheet of water more than fifty miles across. At the entrance of the inner harbour a simple monument has been erected to the memory of the great Spanish navigator Magellan, who was killed in one of these islands in 1521. He (Mr. Workman) was much amused at the masher costume of the young Manillan, who is to be seen gaily going about the streets in the airy costume of a pair of trousers and a very white shirt, the latter garment being worn quite loose, and forming a light overcoat.

The lecturer next proceeded to give a minute description of

pile dwellings, observing that all the native buildings are pile dwellings, or modifications of them, and no doubt were first invented as an expedient for raising houses in the water for protection ; but when the race which for generations had dwelt surrounded by water took to living on dry land, the ancient pattern of architecture was followed with slavish exactness. In these houses what would seem almost an impossibility is nevertheless a fact. The ground floor is an addition to the first story; the verandah serves an important purpose, inasmuch as it is the representative of the platform originally intended for the inhabitants to land on from their canoes. Mr. Mossley, who is a great authority on such matters, points out the remarkable resemblance of many of these pile dwellings to Swiss chalets. In the Swiss chalet the basement, enclosed with stone walls, is usually only a cattle stall. The first story is the dwelling-house, and, as in the pile building, it is constructed of wood. It seems possible that the chalet is the ancient lake-dwelling gone on shore—like the Philipine pile dwelling—and that the substructure of masonry represents the piles which formerly supported the inhabited portion of the house. There are similar balconies in the chalets, representing possibly the platforms. It seems probable that the idea of pile dwellings has in many cases arisen through the escape of natives from enemies by getting into a canoe or raft, and putting off from shore out of harm's way. If the attacked had to stay in such a raft or canoe for some time, they would anchor it in shallow water with one or more poles, and hence might have easily been derived the idea of a platform supported on poles.

The lecturer next graphically described his voyage from Manilla to Hong Kong, which was intensely disagreeable. His first view of Hong Kong greatly surprised him, for somehow or other he expected only a low-lying dirty city, entirely devoid of interest, but in this he was mistaken. The curiously shaped boats in the harbour are of great interest, and mostly manned by the families of their owners. Many of these family boats (sampans) are not over 20 feet in length, and some even shorter, built with a low deck, so as not to have more than three feet head-

room below. He was not aware whether the occupants slept in this low hut, or under a 4-feet long swing immediately in front of the stern. The city of Victoria is situated at the base of a hill rising steeply to a height of over 1,800 feet. It is somewhat like, if one could imagine, the waters of the Belfast Lough rising to the level of the Antrim Road, and the town built between it and the steep rocks of the Cave Hill. When he ascended the hill, which he took an early opportunity of doing, he was almost afraid of setting a stone in motion in case he might bring swift destruction on the houses below. He proceeded to describe the town, elaborately commenting, especially on the Botanic Gardens. The streets of Hong Kong reminded him of the streets of Malta, with its flights of steps and narrow ways, along which no carriage can go, so that locomotion is restricted to walking and driving in jinrickshas, something like an overgrown perambulator, or being carried in a chair slung on poles. Chairs made of cane are slung on very long lance poles, and are very comfortable. In the streets one sees a few Chinese women tottering on their small distorted feet, just like goats' hoofs; but there seem to be two distinct races, for there are many women that do not at all compress their feet. Chinese men of the upper classes have a great dislike to manual labour, and, to show that they are quite above such undignified work, it is considered the proper thing to allow the finger nails to grow to an extraordinary length, so that it is not uncommon to see Chinese gentlemen with nails projecting two or three inches beyond their finger tips. While in Hong Kong he took the opportunity of hearing a sermon in Chinese. The sound is very strange, being quite unlike any other language he had heard. It is a monosyllabic language, and seems greatly to want in expression. It seemed to him to run thus :—" Chuck, lick, sim, sam, sang, he, kang, whang." The lecturer gave several other amusing illustrations of the Chinese language.

On the evening of the 14th January he set out for Canton on board the s.s. "Powhan." The centre of the steamer was occupied by Chinese passengers. From that part the forecastle

and poop were divided off by massive bulkheads, pierced so that the European crew and passengers might at any moment pour in a destructive fire on their Chinese fellow-travellers. The appearance of Canton far exceeded anything in the way of cities he had seen ; it was truly astonishing ; a scene of prodigious life and activity. At Canton foreigners live on a little island called Shameen, which is separated from the town by a canal, over which there are two or three bridges, strongly protected by gates, which are closed every night. These gates were put up recently, he believed, because the mob came over from Canton and had destroyed many of the European houses. This attack was not, however, altogether unprovoked. He had a letter of introduction to a gentleman, who kindly provided a chair with the two bearers and a guide to take him to see the various sights of the city. Soon they reached the midst of the town, with its million and a half of inhabitants on a very little larger area than the town of Belfast. If one were to imagine Bridge Street reduced to the breadth of a narrow lane, lower the tops of the houses to the level of the shop windows, take out all the windows, leaving the shops open, and in some parts roofed to keep off the sun, and then down the sides of the shops and from overhead hang countless boards emblazoned with golden and red characters telling of the class of goods sold within ; sprinkle a good deal of scent over all (not attar of roses), then cram the place with people, and behold Canton. The whole passage was one of knock, jostle, crush, but, being seated on a good chair, he was indifferent. When buying from the Chinese one has to keep his wits about him, as the Chinese are smart at all sorts of swindles. He saw a dog and a nice clean little puppy hung up for sale in a butcher's shop. He saw also a rat hung up for sale. Yet Chinese do not eat dirty things, and they set a good example in the clean and tidy way in which they put out meat and vegetables for sale. A duck hung up for sale in Canton appears not unlike a flatfish, owing to the way it has been prepared for the market. A common article of food is the cuttle-fish. The shops are very numerous. In the furniture shops there are beautifully carved chairs and tables made of

dark wood, which, he believed, came from Singapore. There are shops for the sale of jadestone and other ornaments ; jade is very highly valued by the Chinese, and is a very hard semi-transparent stone, of a dark green colour. While speaking of ornaments, it might be interesting to his audience to state that on 6th May, 1850, the late Mr. Getty, an old and valued member of the Society, read an interesting paper on certain seals found in Ireland, and supposed to be of Chinese manufacture. Mr. Fortune, in his account of the Chinese, says :—"There cannot be the slightest doubt that these seals have lain in bogs and rivers of Ireland for many ages. The peculiar white or cream coloured porcelain of which they are composed has not been made in China for several hundred years. They are very rare in China at the present day." There are also in Canton shops for ivory carving and amber work. The most beautiful sort of work to be seen in the Canton shops is the embroidery. There are numerous coffin shops, for the undertaking business is not done in the retired fashion obtaining in this country. A Chinese coffin is a very ponderous affair, and apparently more ornamental than useful. It is formed of trunks of trees, eighteen inches in diameter, cut in two, and chamfered at the edge, and the flat part slightly hollowed out. Four of these slabs joined at the edges go to form the coffin, and two square pieces of wood fill up the ends. There are numerous eating-houses, some of which supply only the flesh of cats and dogs. One restaurant is known by the name of Whoon-Hang-Kau-Maau-Yunk-Poo, which means the sign of the dog, cat, flesh eating-house. Nearly all burdens are carried on the shoulder suspended at the end of a bamboo pole, and, if possible, the article is divided in two, and a part put on each end. The temples of Canton are not wonderful either for size or beauty. The temple of the 500 genii is well known. A geni means a very wise man. Among these 500 worthies is an effigy of the old Venetian traveller, Marco Polo. Another temple visited was that of the five genii and the five rams. It was from these five rams that the city took its name. The paper concluded with a brief statement of the legend of the five rams

and five genii. Mr. Workman added greatly to the value of his paper by employing, as he proceeded, lantern and photographic illustrations.

The Rev. Canon Grainger made some valuable remarks on the Chinese seals found in Ireland. He said that in 1720 a Dublin tea merchant was reported to have sent out a great number of these seals.

*4th January*, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Alexander B. Wilson, Esq., read a Paper on

## POWER.

Mr. Wilson said the subject of his remarks, "Power and its Transmission," was too wide to be dealt with in the limits of such a paper, except in a very brief way. He had intended to deal particularly with the subject of compressed air as a power, but, fearing that the question would perhaps be too strictly technical and uninteresting if treated alone, and having regard also to his own connection with the Birmingham Compressed Air Company, he had concluded to deal with the matter in a more general way, rather than with especial regard to the most interesting advances in engineering which are going on in the Midland metropolis. Mr. Wilson then proceeded to explain the different terms used in connection with power, as "horse-power," "foot tons," &c. James Watt and the engineers of his time adopted the expression "horse-power" as the most convenient term by which to convey to the mill and mine owners the capabilities of their engines. The original value of a "horse-power" was based on the work it was estimated a healthy horse could do in a working day, and it was therefore based on two quantities—work and time. In engineering a horse-power consists in the power to raise 33,000 pounds one foot in one minute, or 19,800,000 pounds one foot in a working day of ten hours. This is far too high an estimate of the work of a horse, for it would mean the capability of raising four tons in one day of ten hours to a height equal to that of Divis.

Mr. Wilson then went on to speak of the power developed

by gunpowder in cannon, which is measured by artillerists in "foot tons." One of the 100-tons guns manufactured by Sir William Armstrong's firm for the Italian Government developed and communicated to a target placed 100 yards away a power equal to 40,000 foot tons. This power, if able to be maintained continuously, would be immense; for the energy developed by one discharge only of this gun would be sufficient to lift, say, either of the Liverpool steamships Caloric and Optic, weighing, with cargo, coal, crew, and passengers, some 1,410 tons, to a height of thirty-one feet in ten seconds. Unfortunately, however, this great source of power is applicable to few except warlike purposes.

The supply and sale of power for manufacturing and industrial purposes is of quite recent development, but has already become a recognised system in many large towns where manufactures or works are carried on. It is cheaper for manufacturers using only a small quantity of power to purchase than to produce it; but there is a point where, from the amount required, it becomes more economical to produce than to purchase. In Belfast, perhaps from the fact that fuel is dearer than in towns in England and Scotland adjacent to collieries, or perhaps from the shrewdness of the mill-owners, more care is exercised in the economical production of steam-power than in any other town of the three kingdoms. Even in London, where fuel is dearer, the cost of the production of power is far more than proportionately greater. Mr. Wilson then showed by means of a blackboard the proportionate cost of steam-power per year power units in London, Birmingham, Glasgow, and Belfast. From this it appeared that in London the cost per horse-power per annum for engines of six hundred horse-power ranges from £4 15s. 6d. to £7 7s., in Birmingham from £3 13s. to £5 11s. 2d., in Glasgow from £2 14s. to £5 8s., and in Belfast from £2 10s. to £4 6s. He pointed out how rapidly the cost proportionately increases with the decrease of the amount produced. For instance, the year power unit—that is to say, the cost of one horse-power for three hundred hours—in small engines of 25 horse-power and under frequently

amounts to £25 in London and £22 in Birmingham, being proportionately reduced in larger engines. The cost of gas power may be taken as £26 in London, and £20 1s. 10d. in Birmingham, £19 10s. in Glasgow, and £24 in Belfast per year power unit.

Referring at length to the production and development of steam-power, Mr. Wilson said that during the last twenty-five years, except in some minor points of construction, the form and performance of boilers has been unaltered, tubular boilers having then taken the place of flue, and steel has since superseded iron as the material employed in their manufacture, and enabled much higher pressure to be carried with safety. Much, moreover, has been accomplished in marine engineering in the development of power, especially by the use of compound engines. It may be mentioned that, while the quantity of fuel to produce a pound of steam at 160 pounds pressure is only 3 per cent. more than that necessary for the production of a pound of steam at 30 pounds pressure, the available power obtainable from steam at 160 pounds is nearly 100 per cent. more than from that at 30 pounds. It is for this reason that high-pressure engines have become so generally used, and though the advantages of such pressures were known long ago, they could not be utilised, owing largely to the want of a proper oil. Steam at 30 pounds pressure has a temperature of 274° Fahrenheit, and at 160 pounds pressure of about 370°. Of the animal and vegetable oils applicable for lubricating purposes, some of them at the lower temperature answer sufficiently what is required, while at the higher they become completely carbonised and turn into gas. It was not, therefore, until some of the products of petroleum were brought into use that this difficulty was overcome. The only rival, and that an insignificant one, able to hold its own at all hitherto with steam as a power for manufacturing and propelling agency is gas. In gas engines the motive power is developed by an explosion of a mixture of gas and air below the piston of a vessel resembling a steam cylinder. Some manufacturers claim to be able to work with 22 cubic feet of gas per horse-power, but this he had

found by experiment was too low, and he thought that about 30 cubic feet would be about the average. This would bring the cost of gas up to £20 per year power unit. Mr. Wilson went on to explain at length the principles, advantages, and disadvantages of the gas-engine. Among its advantages might be placed the absence of a necessity for a boiler, with its dirt, heat, trouble, and danger, and this makes it favoured in many small concerns. As at present constructed, however, the gas-engine can never enter into competition with steam for heavy work.

Speaking next of the distribution of power, Mr. Wilson said it was not until the experiments of the Compressed Air-Power Company were made (with which experiments he had himself been connected) that it was discovered that the cost of production in small concerns in general was so large as it turns out to be, a fact which was greatly due to the full amount produced not being constantly required, as well as to unskilful management, and other causes. When the figures were published which proved this, and the Compressed Air-Power Company offered to supply such manufacturers with power at £15 per year power unit, demand was immediately made for 4,000 horse-power on these terms. Various means have been used for the supply of power in this way. First, steam sent in mains through the streets from a central supply; secondly, compressed air laid on in the same way, the compression being effected at a central station; thirdly, water supplied by pipes from a central pumping station, and used to drive hydraulic machinery. The first plan has found some favour in the United States, and the dividends of the companies thus supplying power have been from 5 to 24 per cent. However, there are so many climatic causes to militate against such a system in these countries that it can never be thoroughly successful. The second, that of compressed air pumped into mains at a pressure of 45 pounds above the atmosphere, and delivered in the same way as gas, has, he believed, the largest future before it of any of the three. For all purposes to which steam is applicable, except that of heating, compressed air is equally available. Yet while unsuitable for heating, it may frequently be utilised for the pro-

duction of cold. It does not suffer, as steam does, from radiation and condensation. The first development to any large extent was in connection with the boring of the Mont Cenis Tunnel. From this it has extended to a variety of uses where power is required, more especially in coal mines, where to a distance of three miles or more from the mouth of the pit power of any other kind would be impossible to transmit. After the investigations to which he had referred had been made, the Birmingham Company obtained an Act of Parliament, with the sanction of the municipal authorities, for the construction of the necessary works to utilise the system for supplying power to Birmingham manufacturers. It was calculated that of the amount of compressed air transmitted from the central station, a maximum percentage of 84 per cent. could be obtained by the consumer. The average price they proposed to charge is fivepence per thousand cubic feet, and this would entail to the consumer a cost of £6 14s. 6d. on the best percentage, and £17 on the minimum percentage per horse-power per annum. The system would not be economical applied to large engines of 100 horse-power and over. There are two very strong recommendations in this system most satisfactory to the consumer :—these are, that the quantity supplied can be measured with the accuracy of a first-class gas meter ;—and that no heat or fire can arise from it. Speaking of power as developed by water under high pressure and available for supply, Mr. Wilson said this arrangement was first carried out at Hull, and has since been worked in other towns, but it is very expensive ;—the use of a hydraulic motor involves a year power unit cost of from £40 to £60. As for electricity, it remains for some future Watt to devise a plan whereby it can be produced and applied as a force with sufficient economy to compete with the other sources of power.

In the foregoing remarks the cost of the year power unit is in all cases taken as including coal, oil, stores, labour, depreciation at 5 per cent., and interest on outlay at 5 per cent In the larger class of engines the two latter items in some cases exceed the whole of the former, while as they reduce in size the proportion of coal cost rises rapidly.

With respect to the use of compressed air, and specially as comparing it with hydraulic supply, for the use of motors :— In the case of air, the ordinary steam engine, with unimportant alterations, is used, so that the system may be applied to already existing engines, whereas with water special machines have to be provided. Again, air is elastic, and for varying loads on the same engine can be used more or less expansively ; water, being inelastic, each stroke of a hydraulic motor uses the same quantity whether the load be light or heavy. The pipe friction of water as compared with air is roughly in proportion to their densities : taking the former as supplied at 700 lbs. of pressure per square inch and the latter at 45 lbs., the ratio is as 200 to 1. The energy contained in a cubic foot of water at that pressure is but 15½ times that in a cubic foot of air worked even non-expansively, or say eight times that of air worked to best advantage, while its pipe, port, and valve friction is 200 times as great ; and, lastly, in hydraulic high-pressure supply there is no reservoir ;— the accumulators used can only hold a few seconds' supply ;— whereas in air the whole of the mains laid in the streets form a vast receptacle from which supply may be taken for a considerable time without serious reduction in pressure.

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*4th January*, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

The Rev. Canon Grainger, D.D., M.R.I.A., read a Paper on

## A QUESTION CONCERNING THE ANTRIM GRAVELS.

Rev. Canon Grainger read a paper on "The Antrim Gravels," referring to the absence of the characteristic stratification near the surface of gravel hills, and attributing it to the action of sub-glacial rivers at a late glacial period.

Canon Grainger also exhibited a most interesting collection of Chinese, Indian, and other antiquarian specimens, including a magnificent set of jade axes and other instruments.

*1st February*, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Seaton Forrest Milligan, Esq., read a Paper on

## RECENT ARCHÆOLOGICAL EXPLORATIONS IN COUNTY SLIGO.

Mr. Milligan said :—The opening meeting of the present Session of this Society was inaugurated by an address from the President on "Some Later Ideas Concerning the Round Towers," when the theories propounded by various writers on this subject were fully discussed. It has occurred to me since this paper was read, that amongst people not conversant with the subject the notion largely prevails that the round towers are the most ancient stone buildings in Ireland. This idea is not by any means accurate, as we have other remains of circular stone buildings or forts that were hoary with the lapse of centuries before the first round tower had its foundation laid.

I am considerably within the mark when I state that there are structures of this class existing in Ireland for more than 2,000 years. If the Annals of the Four Masters are accurate, we have one in Ulster—the Grimian of Aileach, the building of which was completed 1,700 years before the birth of our Lord. These structures have not been written about so extensively as the round towers, and there is less of mystery as to their erection and use. We have not so many perfect examples of them as the round towers; many are dilapidated, and others have only their foundations left to show where once they stood; but the remains that are left point to a period and a civilisation long departed. I refer to the Cashels, or, as they were commonly known to the ancient Irish, the Cathairs, of which I will have

something further to say, having found five of them, or, more strictly speaking, the remains of five Cashels, not previously described. I will also refer to certain sepulchral structures, such as giants' graves, of which I have found a few examples, and another class of stone structures, scarcely if ever referred to by Irish archæologists, which will be rather a new feature to bring before you. I refer to alignments, or lines of standing stones. All these monuments are situated in the county of Sligo, within a radius of five miles from the town of Sligo. Alignments have been found in great numbers in the Department of the Morbihan, in Brittany, particularly in the vicinity of the village of Carnac, in the same district. They have been a puzzle to archæologists as to their use and the motives which led to their erection. I have a hope that the study of Irish alignments will tend to throw some light on these rude stone monuments of ancient times. I have examined a series of photos of alignments in Brittany, from which I have selected three that resemble those in Sligo, which I will place before you on the screen for comparison. The only structure I will refer to previously described is the great megalithic monument in the Deer-park of Hazlewood, concerning which I shall have some further additional facts to place before you.

"County Sligo possesses many places of great interest and beauty; bold cliffs, romantic dells, as at Glencar and Knocknarea ; well-wooded demesnes, as at Hazlewood ; lakes of rare beauty, which yet differ widely in feature, from the cultivated and picturesque surroundings of Lough Gill to the gloomy, wild tarns of Lough Easkey and Lough Talt. Mountain, sea, lake, and wood combine to render the scenery attractive. It affords a field of study to the botanist, the painter, and the antiquarian. In the mountains are rare ferns and Alpine plants. It possesses the most picturesque and varied landscapes, and abounds in objects of striking interest to the antiquarian. Some of the earliest seats of Christian learning are to be found within its limits, as also several of the earliest known Pagan monuments, contrasting in their hoar antiquity with the remains of castles and fortified houses of the settlement which belongs to the

nearer epochs." Such is a condensed description of the county taken from Col. Wood Martin's recent History of Sligo. I have known the county Sligo for many years: its lakes, rivers, mountains, glens, and its warm-hearted and hospitable people, and I must say that I do not in Ireland or elsewhere know of any other district I would prefer to it for spending an instructive and enjoyable holiday. By whatever road the visitor approaches the county Sligo lovely scenery meets his view; the old coach-road by Manorhamilton is very beautiful, "over the Irish Alps," as a driver of Bianconi's used to designate the picturesque pass of Marah.

The route by Dromore West, Screen, and Ballysadare, with its ancient church and magnificent cascades, is also fine. But the most charming road of all is that of Bundoran, Cliffony, Grange, and Drumcliffe. On our left as we proceed this way, we have a splendid mountain range nearly all the way. Benweeskin, Benbulbin, and Turskmore, are the most prominent heights, ranging from 1,722 to 2,213 feet above the level of the sea. Should we ascend Benbulbin, which is comparatively easy, what an extensive prospect meets our view! To the west is the broad Atlantic, to the north-west the Bay of Donegal, protected on its western side by the magnificent mountain of Slieve Leagh, whose perpendicular cliffs on the seaward side are almost 2,000 feet in height. We can observe in the far distance in Mayo the high cone of Nephin, and further still lying off the Erris coast the stags of Broadhaven. Nearer us, to the south, is the range of the Ox Mountains, also Knocknarea, with its huge cairn, Miscaun Meabh, at the base of which lies Carrowmore, with its ancient monuments of the battle of North Moyturah.

Right under us, towards the east, is Glencar valley, with its waterfalls, lake, and crannoges. Between us and the sea, is the ancient plain of Magherow, which contains many forts and sepulchral structures, also some very extensive souterrains, which I have examined and will refer to at another time. Almost at our feet, to the south, is the village of Drumcliffe, with its round tower, cross, and pillar stone—one of the earliest seats of

Christianity in Ireland, founded by no less a personage than St. Columbcille, in A.D. 585. Drumcliffe was burned by the Danes after they had plundered Innismurray, which was the first spot these sea rovers landed on in the western coast in the year 807, when they had a sail of 50 vessels.

Lying off the coast some four and a half miles is the Island of Innismurray, celebrated up to a recent period for the very fine mountain dew distilled there—which did not much increase the Imperial revenue—but more famous as the residence of St. Molaise in the 6th century ; not the St. Molaise of Devenish in Lough Erne, but another celebrated man bearing a similar name, which is to the present day a household word in Innismurray. Here are many monuments of Pagan and early Christian times—pillar-stones of undoubted Pagan origin, afterwards consecrated by the Christian saints with the emblem of their faith—the cross—carved in various styles.

These early saints were wise in their generation. Instead of rudely breaking the people off their stone worship, well worship, and Pagan festivals, they consecrated them all to the service of the new faith. They carved crosses on the pillar-stones ; they baptised the converts at the sacred wells ; they turned the Pagan feasts into Christian festivals, and thus the change to the new faith was the more easily accomplished.

It was by the route last described—by Bundoran and the coast—that the armies of Ulster used to invade Connaught, sometimes led by an O'Neill, at other times by an O'Donnell. There were battles fought here in very ancient times, which we need not now refer to ; suffice it to say, this is classic Irish soil. Its ancient history, if recorded by another Walter Scott, would lend a charm and an interest to it equal to any in Europe.

Though this country has been a favourite resort of antiquarians for more than a century past, there still remain many interesting relics of by-gone ages, the existence of which have never been recorded. Beranger, who visited it in 1779, was one of its first explorers. Afterwards Dr. Petrie in 1837, and Mr. Walker of Rathcarrick, at whose seat the ancient stone chair or seat on which the O'Neills were crowned, is still preserved. How it was removed

from the Linen Hall, Donegall Street, Belfast, to county Sligo is related in the *Dublin Penny Journal.* Mr. Walker, who lived at the early part of the present century, opened many of the ancient sepulchral monuments in county Sligo, without leaving any record of the various finds he made, and afterwards disposed of them to an English nobleman, thus doing an irreparable injury to Irish archæology.

Amongst the more recent explorers are Mr. James Ferguson, author of "Rude Stone Monuments;" Colonel Cooper, of Markree; Colonel Wood Martin, the present indefatigable Editor of the Journal of the Royal Historical and Archæological Association of Ireland; Mr. W. F. Wakeman, and others who have given interesting records of ancient monuments of Pagan and Christian origin. Amongst those are the cromlechs, stone circles, and forts, in the townland of Carrowmore, within three miles from Sligo, and first described by Beranger during his visit in 1779. The visit of Beranger to Innismurray in that year is a most interesting narrative, as recorded in a late number of the Archæological Journal, where the primitive customs of its inhabitants are described. Mr. W. F. Wakeman has copiously illustrated and described the plain and inscribed monuments of Innismurray. There is also the great megalithic structure, or, as it is called, the Irish Stonehenge, situated four and a half miles from Sligo, in the townland of Magheraghanrush, to which I shall again refer. This ancient and unique monument is described in the Journal of the Royal Historical and Archæological Association of Ireland, in a paper read by Mr. Edward T. Hardman before the meeting held in Kilkenny on 16th April, 1879. It is also referred to by Mr. James Ferguson in his book on "Rude Stone Monuments," published in 1872. In January, 1886, I visited the Deerpark, accompanied by two friends from Sligo. We went to it for the purpose of examining this monument, and to more thoroughly explore the Deerpark.

The lecturer proceeded to describe this great structure, of which he had maps and accurate measurements. It is 104 feet in length, and 28 feet in breadth at the widest part. Mr. Fer-

guson and Mr. Hardman described it as having a likeness to a cathedral, with its nave, aisles, etc.—but he formed a different opinion, and proceeded to show its likeness to the rude outline of a giant figure cut in the ground, and the figure outlined with huge standing stones from three to six feet in height. Mr. Hardman in his paper says :—"I will not venture on any theory as to the use of this structure, except so far as to suggest that it was the place of a ceremonial observance of some kind. It is clearly not a sepulchral structure, seeing that the solid rock occurs within a foot or so of its surface." He then proceeds to show, borrowing the idea from James Ferguson, that it resembled in its plan a cathedral. What Mr. Hardman supposed to be the natural rock is an artificial flagging which covers the entire of the structure—of which more hereafter.

Mr. James Ferguson refers to this structure as follows :—"What, then, is this curious edifice? It can hardly be a tomb, it is so unlike any other tomb which we know of. In plan it looks more like a temple—indeed it is not unlike the arrangement of some Christian churches ; but a church or a temple with walls pervious as these are, and so low that the congregation outside can see all that passes inside, is so anomalous an arrangement that it does not seem admissable. At present it is unique, if some similar example could be discovered, perhaps we might guess its riddle."

Mr. Ferguson made no attempt to solve the riddle, neither did Mr. Hardman. The only mode of discovering the secret was by the spade and pick. Having secured the services of two men, we removed the surface soil, and everywhere we examined underneath it was found covered with flat flagstones, below which were loose stones to a depth of another foot. We there found little cists, at a depth of about two feet or better from the surface, containing bones. These cists we found in various places inside the structure, and in every instance contained bones. These bones were forwarded to Dr. Redfern, who kindly examined them, and reported that the human bones had come from bodies, at least three adults and one young person. The animal bones were split to expose the marrow cavities, and were probably

used at a funeral feast. There were bones of the ox, goat, hare, etc. The lecturer read a letter he had received a few days previously from a man who lives in the neighbourhood of the Giant's Grave. He says :—" About twenty-five years ago the landlord of the place made an excavation in the Giant's Grave at the western end, near to the large headstone, at a depth of about eight feet or more from the surface, he found human remains in a vault or crypt of uncemented stones. Several people have still a recollection of this circumstance, so that it is now placed beyond a doubt this structure was erected as a sepulchral monument." * Nothing in the way of weapons, ornaments, or cinerary urns were found in it.

Mr. Elcock, who is an experienced archæologist, and who carefully examined this structure, arrived at the conclusion that it resembled a human figure. Mr. Elcock's opinion and mine were arrived at quite independently of each other. The structure lies almost due east and west—the head at the western end, and what resembles the limbs of the figure at the eastern end. The entrance to the structure is by a passage about two feet six inches wide in the centre of the structure, or looking at it as a likeness to a human figure, this passage is in the centre of the body, at a point that would correspond to the umbilic. It has three trilithons or open doorways, one between the head and body of the figure, at what would correspond to the mouth, and two at the extremity of the body where the passages that correspond to the limbs commence. This is the only structure in Great Britain where there are trilithons except Stonehenge.

The lecturer next proceeded to describe the ruins of a great cashel situated a little to the south of the Giant's Grave. The internal diameter of this cashel is exactly 100 feet, with encircling wall 13 feet thick, the remains of which still stand to a height of from three to four feet. An immense quantity of loose stones, the remains of the original structure, lie scattered around, and a still larger quantity were removed some years previously, for the purpose of building fences. The entrance to this cashel

* **N.B.—Since this paper was read, Colonel Wood Martin has made further excavations, and found a great quantity of bones.**

is well defined. It is on the southern side; is three feet nine inches wide on the outer side and is three feet six inches on the inner side. The entrance passage is thirteen feet through the thickness of the wall. On the right side of this passage as you enter there is a recess of about six inches deep. I also observed a hole about two inches in diameter drilled to a depth of twelve inches in a large stone. It occurred to me this hole was used for inserting the hinge for the door, and the recess on same side was intended for the door when open to fall back into and leave the passage clear. In the Grimian of Aileach* there are two recesses, one to right and left as you enter, about midway in the passage. I would conclude from this there were two doors, one on either side, closing in the middle, the joint breadth of the recesses being about equal to the width of the passage. If the doors were of stone this would be obviously a good arrangement.

In this cashel the recess is equal to the width of the entrance, which goes to show it was closed by a door hung on one side. There is an angular shaped souterrain in the middle of this cashel, terminating in a bee-hive shaped structure. One of the sides measures eighteen feet. In all cashels I have examined, where the nature of the ground permitted, these chambers were constructed in the ground. At Aileach, which is erected on the solid rock, there are two chambers constructed within the thickness of the wall, one on each side of the doorway. In no instance have I observed chambers in the wall where the ground could be easily excavated. These souterrains and chambers were no doubt intended as storehouses and receptacles for valuable property, as the entrance to them could be so easily concealed or defended.

The lecturer next described another sepulchral structure situated to the south-east of the cashel in the Deer-park. It is like three ruined cromlechs, with the covering stones fallen off

**Note.*—Since this lecture was given, the lecturer had the pleasure of inspecting the Grimian of Aileach with a friend, accompanied by Dr. Bernard of Derry, to whom Irish archæologists are under a deep debt of gratitude not yet acknowledged, for his great labour in restoring this ancient and historic structure.

and lying against the upright stones. At a further distance of about half a mile up the eastern side of the Deer-park, is the remains of another cashel, 180 feet in internal diameter, the encircling wall of which was eight feet in thickness. Within the outer circle are the remains of three interior forts lying from north to south, whilst in the western side the remains of a souterrain filled with *debris* is quite visible. This cashel possessed this advantage: that if a breach were made in any part of the outer encircling wall the interior forts could be defended, which added greatly to the strength of this ancient fort. The stones from this cashel were removed within the memory of people still living, for the purpose of building fences round the Deer-park.

A very peculiar-shaped stone, which the superstition of the people has protected from being removed, is still lying on the eastern side of this cashel. It is known as a Bullan Stone. It is about three feet high and about two feet square ;—on its top a basin-shaped cavity is cut to a depth of four and a half inches, with a diameter of eleven inches. The water which lies in these stones is considered by the people as a certain cure for diseases of the eye. Bullan and other cup-marked stones were worshipped in Ireland in Pagan times, and are still held in peculiar veneration by the people, instances of which were given. Earth-fast rocks and stones with cup and ring markings have been observed in India quite similar to those found in Ireland. In India they are still worshipped, and their symbolic meaning understood, in connection with the worship of Siva, who, under the name of Mahadeo, is worshipped as the generator, the sun, etc., and whose type is the Linga. Benares is the head-quarters of this Lingam worship; in temples devoted to it the richer people erect stone pillars over the graves of the departed, whilst the poorer are satisfied with a section of the ground plan of this in the form of two concentric

*Note.*—The lecturer since reading this paper examined another cashel in county Sligo, the walls of which stand ten to twelve feet in height. It is built on a rock, there is a chamber in the thickness of the wall, and a recess in the entrance passage, together with an outwork not observed in any other cashel.

circles and a central dot, a symbol that has been carved on the rocks all over Europe. Bhavini, the wife of Mahadeo, is supposed to represent the feminine principle in nature. Some light may be thrown on European rock-markings by noting the symbolic meanings held in India concerning them.

A cave dwelling situated a little to the north of the last cashel, 55 feet in length, was next described. It divides in the centre into two chambers, and is from nine to ten feet high and five feet wide. At the entrance to this cave the remains of an ancient hearth was found, and in the midden adjoining, at a depth of two feet, a quantity of bones, and a small bronze buckle, carved on one side, were found.

A description of the townland of Carns was next given, and a map, enlarged from the six-inch Ordnance Survey, was shown, with the various places of antiquarian interest drawn to scale. First, the two huge cairns, situated in a most commanding position on the high ground overlooking the town of Sligo. Next, the outlines and remains of three cashels were described, varying from 60 to 80 feet in internal diameter, with walls from eight to ten feet in thickness. The wall of one, which is ten feet in thickness, stands to a height of about three to four feet. Two of them have the remains of souterrains or cryptic structures, and one has the remains of two encircling concentric walls, thus showing another type of cashel. The most important feature to archæologists are the alignments extending across the hill and parallel to the cashels. A transverse alignment extends up the hill to the cairn of Ton-na-fhoble, a distance of about three-fourths of a mile. In some parts of this alignment the stones are deeply embedded in the ground, and in some places they disappear, but it can be traced till it reaches the cairn on its southern side, at a point where there appears to be an entrance into it. There are three almost parallel lines of stones stretching across the hill, slightly converging at the western side. The length varies from 500 to 600 yards; they run in a line almost due east and west. The distance between the most southern line and the next one is about 100 yards, and the distance from the central line to the more northern one

is about 130 yards. The centre alignment is formed of the largest stones, and they increase in size towards the western end. Where this line terminates to the west, there are two enormous menhirs, one of which measures 11 feet in height and 42 feet in girth, the other measures 10 feet in height and 30 feet in girth. These two immense stones stand quite closely together, and seem from the cleavage to have been originally one. There is an almost complete circle of large boulders, of which the two whose dimensions I have given form the centre. Six stones form the circumference, separated from each other by a distance of about 30 yards, while their distance from the two central stones varies from 25 to 30 yards; there is one stone wanting to make the circle complete. There is a row of stones extending north and south, dividing this circle almost equally in a line with the two central boulders. Besides the two latter there are ten very large stones standing upright—the distance separating them is from 24 to 35 yards, and the entire distance they extend is about 226 yards, about equal to the distance separating the lines that run east to west. In the latter lines the stones are placed closely together, while in that extending north and south they are separated from each other as already mentioned, and are of much larger size.

Reference was next made to similar alignments found in Brittany, in the department of the Morbihan, of which a few views were shown on the screen and compared with those in Sligo. Antiquarians who have spent a great deal of time and research in examining the lines of Carnac, Menec, and Kerlescan, have not arrived at a definite conclusion as to the use of these monuments in the ceremonies of the ancient inhabitants of Brittany. The general opinion is, they were in some way connected with sepulchral structures, and had a place in the worship of the early Celtic tribes.

Proceeding from where the alignments end on the eastern side down hill towards Lough Gill, we entered a field containing the remains of a small circular fort. In the same field are 18 small cairns, or heaps of loose stones, with other stones placed *in situ* outlining the graves, for they are evidently sepulchral

structures. In the next field, still nearer the lake, there is a great pit 75 feet long and 30 feet wide at the broadest part. It is filled with hundreds of loads of loose stones ; from one part of it the stones have been removed to a depth of six feet. On a portion of the northern side are upright stones outlining this place in a similar way to many sepulchral structures I have seen. It occurs to me that our ancient history throws some light on these graves and their date.

The Annals of the Four Masters relate that in the year 535 a great battle was fought between Eoghan Bel, King of Connaught, and the Clanna Nial from Ulster, at a place called Crinder. The Annals state that at this battle, which was fought with great fury, the River Sligeach bore to the sea the blood of men with their flesh. Another ancient manuscript, translated by John O'Donovan, states—"That Eoghan Bel was mortally wounded, and his troops beaten by the Ulstermen ; that he lived for three days. He told his people to bury him on the hill at the base of which the Ulstermen flee when pursued by the armies of Connaught ; that he was to be buried in a standing posture, with his red javelin in his hand and his face towards Ulster, that he might watch over his countrymen when engaged in battle." It is further related, so long as his body remained in this position the Connaughtmen were victorious ; but the Ulstermen coming to know of it, came with a great army and removed the body, and carried it northward across the Sligeach river, and buried him with his face downwards at Aenach Locha Gille—thus destroying the talismanic effect of the former interment. The present river running from Lough Gill to the sea, a distance not exceeding four miles, was anciently called the Sligeach. It is on the southern side of this river, and close to it, that the eighteen graves and the large pit is situated.

The large cairn, or what is known as Carns Hill, is on higher ground, overlooking the lake and river. The battle must have been fought here, as the Annals state the slain were carried to the sea by the river. On the hill above the river the cashels

already referred to are situated—a very strong place for the Connaughtmen to fall back on. The graves and pit can be accounted for as the place where those slain in this battle were interred. The large cairn answers to the description of the place where Eoghan Bel was buried, and the chasm down the northern face of the cairn is explained by the body having been removed from that side, and thus causing a displacement or gap in the structure still quite visible. An explanation is required as to the name of the place where the battle was fought. The Annals say it was a place called Crinder. No name like this is now known in county Sligo. If this place was anciently known as Crinder, or Crune Tyr, probably, it would be very appropriate, as referring to the rounded or globular-shaped country, viz.—*crune*, rounded or globular, and *tyr*, a country. Carns Hill is of this shape.

This townland could only have been known as Carns from the time the cairns were erected, and must have had a previous name, which I conclude was the now lost name referred to—from the fact of the burial of the King and the erection of his cairn, and also the erection of the other cairn known as Ton-na-fhoble, or the cairn of the people—the townland from that period would be referred to and called Carns, and the older name would lapse. The lecturer proceeded to prove that the place the body of Eoghan Bel was re-interred in would correspond to the structure now known as the Giant's Grave in the Deer-park. Ancient stone worship was exhaustively dealt with, and the decrees of the various Councils of the Church against stone worship, well worship, and the worship of trees, was referred to.

The use of stones in the inauguration of chiefs and kings in Ireland, and Edmund Spenser's account of such a ceremony which he witnessed in the South of Ireland, was related. The chief was placed on a large stone reserved for that purpose, usually on a hill; he took an oath to preserve all the ancient customs of the country inviolate; he then received a wand, after which he descended from the stone. The ancient

Kings of Denmark were crowned in a circle of stones; the Kings of Sweden were crowned on a stone, around which was a circle of stones on which the nobles sat; the Saxon Kings were crowned on a stone; and the British Sovereigns are crowned with a stone placed underneath the coronation chair. The Kings of Ireland were crowned on a stone at Tara. The O'Neills were crowned on a stone seat which is now in the Co. Sligo.

A very peculiar custom which throws light on Druidical stone circles was referred to. The bards from Wales assembled in the gardens of the Temple, London, in November last, to hold a meeting called a Gorsedd. Twelve stones were placed on the ground, forming a circle; a large stone was placed in the centre. When the ceremony commenced, the bard, who on this occasion represented the Arch Druid—a venerable man of eighty years—who stood on the central stone, and turning his face to the east commenced the ceremonies of the bards, which custom has been handed down from ancient times. Tradition requires that these Gorsedden, or meetings of the bards, shall be held in the eye of the light and the face of the sun. The large boulder, surrounded by a circle of stones as previously described, may have been used for some such purpose, or in the inauguration of chiefs.

It is said the Kings of Sweden were crowned on a stone within a circle of stones, and for each king thus crowned an upright stone was placed in position as a memorial of the event, so that by counting these upright monumental stones the number of kings crowned there could be known. As already stated, Irish chiefs were inaugurated on a stone, as related by Spenser; that being so, might account for the large boulders within the circle, while the ten stones in line might have been erected as in Sweden, to represent the number there inaugurated.

The lecturer concluded by referring to the burial of Absalom, over whom, when interred, a great heap of stones was placed, like the cairns of the ancient Irish. He also quoted the burial of Hector as an illustration of another mode of sepulture

common in ancient Erin, viz., cremation; and the erection of what was probably a cromlech covered with an earthen mound. After the body was burned on the funeral pyre—

> "The bones they took and laid them in
> A casket bright with gold,
> Wrapt round with fleeces soft and sleek,
> All purple to behold.
>
> Soon scooped a grave and in it entombed
> The casket deep,
> And big stones closely o'er it placed,
> And o'er the stones, still hot with haste,
> Flung up the earthen heap."

*1st March*, 1887.

William H. Patterson, Esq., M.R.I.A., in the Chair.

William Gray, Esq., M.R.I.A., read a Paper on

## TECHNICAL EDUCATION AND OUR METHODS OF PROMOTING IT.

Mr. Gray commenced his lecture by tracing the development of animals, and stated that man is the highest form of animal organisation; that henceforth all improvement must be by man's powers of adapting the phenomena of nature to serve his purposes, and not by adapting himself to his surroundings as the mere animal did. His first effort was, doubtless, the formation of a weapon or tool, and his few rudely-fashioned stone implements were the first step outside of, and beyond the capacity of, any previously existing animal, thereby initiating those processes which culminated in the higher achievements of mechanical skill, demonstrating that necessity is the mother of invention, and foreshadowing the advantages of that competition which is the life of trade. The phenomena of mind, the new factor in the struggle for existence, early attracted the attention of increasing mankind, and gave rise to schools of mental speculation, employed in formulating the laws on which the security of society depends: so that in the earliest ages, and in the infancy of nations, it was found that no progress could be made until an obedience to law and order was first established.

Mr. Gray, having traced the rise and progress of the industrial arts from the East through the Romans to Britain, explained that our insular position was not unfavourable to the

progress of mechanical arts in times of peace, and the successes of our arms by land and sea brought the British into contact with other nationalities, and obtained from them the knowledge of materials and methods unknown to us before. We exchanged with other nations in the markets of the world, and men of thought and skill sought refuge in England from the strife and turmoils that disturbed their native provinces. Edward III. encouraged clothworkers from France to settle in Norfolk and other places, for at that period, as Fuller in his Church History tells us, the people knew "no more what to do with their wool than the sheep that wore it." A most important accession of skilled workmen was obtained in consequence of the persecutions that followed the revocation of the Edict of Nantes in 1685, when a large number of workmen in various trades took refuge in England, and were instrumental in stimulating industries in the various towns then rising into importance. This important accession of the Flemish and French refugees to our slowly-increasing army of skilled mechanics stimulated our industries, and contributed to the development of those remarkable discoveries that subsequently revolutionised the industrial world, and did more for the material welfare of mankind than ages of abstract speculation, religious controversy, and military campaigns. But great discoveries were not the outcome of single minds. Robert Stephenson said of the locomotive, "It has not been invented by any one man, but by a race of mechanical engineers." The same may be said of many other important inventions ; for like as the lowly coral polyp toils quietly, laboriously, and unostentatiously in the deep, generation after generation passing away, in the effort to elaborate and combine the scanty materials of which the reef is formed, and the winter's storm waves roll far above heedless of the toilers, but do not check their progress, until at length their combined result rises gracefully to bask in the sunshine and the air, a very refuge in mid-ocean, to become clothed with fruitful palms and the beauty of tropical vegetation :— so also generation after generation of obscure toilers investigate phenomena, and accumulate experiences in the quiet of their

retirement, with apparently no practical results, and heedless of the contest of parties and the struggles of native rage around them, until at length the combined results of the continued achievements of human intellects develop into some great discovery recognised in the sunlight of public favour as another vantage ground from which to press forward the cause of civilisation and progress.

The brilliant and rapid advance of scientific discovery in modern times, and the vast improvement in mechanical appliances, justify the anticipation of accelerated progress in the future. There seems to be no practical limit to the development of industry, or to the application of the products and forces of nature for the purposes of mankind, wholly independent of nationalities. The common result, as well as the special advantages of every accession and every fresh discovery, are rendered available to all by the increased facilities for intercommunication and the removal of those hindrances, social and physical, that heretofore separated nation from nation. But while the universal distribution of knowledge, and all the advantages that follow discovery and the culture of science and art are inevitable, and desirable in the interests of advancing civilisation, they involve from a commercial view, a closer competition and a keener struggle for existence, and remind us that the position we or any people can take in the struggle, will depend upon the skill, experience, and culture we employ to maintain it. In mediaeval times the squire, the clergy, the yoemen and well-to-do citizens were bound by law to train up their descendants to practical industries. The obligations thus imposed were liable to inconvenient abuses, and the practice fell into disuse, and was superseded by the apprenticeship system. Under the apprenticeship system a youth, bound to serve his master for a term of years, had a fair chance of acquiring a knowledge of his trade, for it brought him into direct contact with his master, and was made familiar with all his business. This was especially the case so long as almost every tradesman was himself a master, and not a mere journeyman in the employment of others.

All the operations of industry were then protected and regu-

lated by trade guilds, and a knowledge of the trade was considered a mystery, jealously guarded by the members of the guilds, who were masters of the mystery—craftsmen or handicraftsmen. In modern times the printer's "devil" has outwitted the craftsmen by exposing all their secrets. In rural districts masters were not so much specialists as all-over men. A smith was a blacksmith, locksmith, nailer, farrier, and perhaps horse doctor. A carpenter was also a joiner, wheelwright, cabinetmaker and millwright. Their factories or workshops were their own homes, in which the apprentice often resided, or, at all events, was brought into daily personal contact with his master, and was thereby enabled to acquire a thorough knowledge of his trade. But the development of manufacturing machinery, with the consequent erection of large manufacturing concerns, and the concentration of skilled labour into large towns, destroyed the apprenticeship system; and to-day the youthful apprentice is passed into a factory, like a sheep into a paddock, to do the best he can for himself. He has no immediate responsible master. But as extensive factories and large establishments of all kinds have become an absolute necessity to keep pace with the progress of our manufacturing industries, and as the principle of a division of labour must be acted on to secure excellence and economy, it is quite manifest that the system of apprenticeship, which cannot be dispensed with, must be modified to meet the requirements of modern industrial operation. The apprentice should, in fact, be technically educated, or he cannot acquire in the workshop or factory the skill that is required by the refinement of processes, and the straining after excellence and perfection in every detail of our modern industries. In this sense we must look on technical education as a system, and not as a mere branch of education—a system that directs every stage of the pupil's educational career, so that he may be prepared to efficiently discharge the duties of life and maintain the struggle for existence. Adopting this view of technical education, it is evident that as a method or system of education it can be applied to our most elementary schools, as the foundation of our educational edifice; and as

the stability and permanence of the superstructure depends upon the efficiency of the foundation, it is manifest that anything wanting or imperfect in our elementary education will be proportionately injurious to the educational superstructure raised upon it.

After referring to the defects of the purely voluntary system, Mr. Gray referred to the establishment of our National education system, and said that in consequence of the apathy of the public, denominational jealousies, and other causes, the old parochial idea was retained in formulating the National education scheme, and the control of the schools drifted into the hands of clerical managers, and consequently the system as a system, while it had accomplished much good, has failed to realise all that its founders anticipated with reference to technical education. If we compare our school buildings with the schools of England and Scotland, we will find a marked contrast. The great majority of our National schools are built on waste, good-for-nothing spots. The buildings are dingy, uncared-for, ill-ventilated, and badly lighted. The report of the Education Commissioners shows that over 23 per cent. of our National schools are without any out-offices, yards, or playgrounds. At a meeting of the Teachers' Congress in Dublin Dr. Cameron said :—" In the rural districts the schools were, with a few exceptions, wretched structures, being sometimes mere mud cabins, with cold clay floors and thatched roofs. Taken as a whole the National schools were mean, ill-conditioned buildings, quite unworthy to be used in connection with one of the noblest of man's works—the cultivation of the human understanding." Such is the testimony of a sanitary authority. We speak of the necessity for compulsory education. Would it not be a breach of Martin's act against cruelty to animals to compel children to attend such schools ? .

The total absence of suggestive objects, natural and manufactured, is a most radical defect in our national schools, for without them our youths are brought up incapable of appreciating the phenomena of the natural world, or its requirements, and consequently know nothing of the various channels into which

their own labour might hereafter be practically directed; hence when it is time for lads to leave school both they and their parents are too often utterly at a loss to know what the lad is to be put to, or what he is fit for. He has been taught to work hard to get result fees for his teacher, and he is glad to be relieved from this labour. Beyond this he has rarely no other definite idea as to the necessity, value, or object of the education he has received. Without this he is heavily handicapped in his future struggle for existence. Referring to the use of tools in schools, the lecturer said there are many things desirable that are not always practicable. This seems to be the case with reference to teaching the use of tools in schools, where our youths, as a rule, have so short a time to devote to the cultivation of the senses and mental faculties as means for acquiring and properly applying the laws and principles that underlie the practical industries of the country. Other agencies besides tools may be employed for the purpose of developing and directing manipulative skill, or dexterity of hand, such, for example, as drawing and modelling. The lecturer strongly recommended this, as well as the study of natural science, and stated that the defective training in the elementary school is a great hindrance to the effective working of the more practical classes under the Science and Art Department, for a great deal of the students' time is lost in their school making up the elementary deficiencies. This is most marked. The School of Art and the teachers' time, which should be devoted to the more advanced studies, is wasted in endeavouring to get the student to grasp the more elementary lessons in drawing. No wonder that the parents and friends so often complain of the time spent on elementary work, and the slow progress made by the students. Mechanics wanting this elementary instruction attribute their slow progress at schools of art to the teachers' want of practical knowledge rather than to their own want of elementary knowledge. Had the student's eye and hand been properly trained in the elementary school at the time when the eye and hand are most readily trained, he would be prepared to profit by the teaching in the School of Art, and advance to higher stages more rapidly. The lecturer

having referred to the want of prizes or rewards of some kind in connection with our National schools, said the children of Model schools obtain certificates and prizes as the result of annual examinations, and there seems to be no reason why a similar system should not be insisted upon in every ordinary National school as a means to stimulate efforts to excel and to deserve, and in acknowledgment of superior merit. At present our National or elementary schools have no direct connection with the Intermediate or higher schools. There is a missing link in our educative chain which should be supplied by a system of scholarships open to pupils of our National schools, thus connecting the elementary schools with the intermediate and higher schools, and making the way clear for worthy pupils to pass from the lower forms of our provincial schools into the highest places in our educational system. Our Schools of Art and Science established in 1851 constitute effective agencies for promoting technical education. During the ten years that succeeded the Great Exhibition of 1851 the art schools worked quietly and effectively, and their influence on the industrial progress of the country was acknowledged by foreign juries in the Exhibition of 1862, who stated that England had "made amazing progress." Since then, further improvement has been made, and the resources of the central schools and museum at South Kensington have been greatly extended, with correspondingly increased advantages to the provinces. The number of national scholarships taken by any school may be accepted as a very fair indication of the efficiency of the school. In this respect Belfast has done well, and occupies a high position in comparison with many others in the kingdom. During the fourteen years following the establishment of our local School of Art, Belfast has taken the third place among the schools of the kingdom. Within that period the number of scholarships taken by South Kensington was 16, Birmingham 10, Belfast 8, and no other school took more than 6. The science classes at the Working Men's Institute, under Mr. Barklie, have been equally successful, and last year the result fees, independent of prizes, amounted to £600. In common with the manufacturers of the nation

generally, our local manufacturers seem to be unconscious of the importance and value of such agencies as our schools of art and science, and take very little interest in their labours. So recently as the inquiry of the Technical Commission in Belfast, a local manufacturer stated that the School of Art was of little use to manufacturers, although at that very time his manager was negotiating for the employment of one of our pupils as a designer in his works, and has employed school of art pupils since with acknowledged advantage. The technical education of pupils must become more specialised as it advances, and in order to meet the requirements of trade, must be carried much further than the education provided by the State. For this purpose all available external agencies must be brought into operation, among the most ancient and honourable of which stand the wealthy livery companies of London, who, recognising the necessity for promoting technical education, established in 1877 the Guilds of London Institute, for the purpose of promoting technical education among the industrial classes. Their general scheme was formulated on the lines of the Science and Art Department, and developed to a practical issue the annual examinations and technical subjects, which were previously organised by the Society of Arts in 1856. The institute's syllabus contains thirty-five subjects, including all our productive industries, and payments are made to teach and support prizes awarded to pupils upon the results of examination in each subject. We have, therefore, working side by side these two agencies for the promotion of technical education among the working classes—the Crown, by means of the science and art schools, and the Guilds of London Institute, by means of the technological programme, taking up the student where he is left by the State, and teaching him the practical application of his acquired knowledge of science and art.

The lecturer described the very excellent work done by the pupils of the Technical School and the Science and Art Classes, particularly the classes at the Working Men's Institute, showing that in the national competitions the Belfast students have more than held their own in competition with some of the most

important Schools and Colleges of Science in the kingdom. Referring to the difficulty in getting Schools of Science in the country, the lecturer said these difficulties and hindrances must continue until local authorities awake to see the necessity for adopting some more systematic method of applying the educational resources of the country for the purpose of promoting the interests of our national industries. In this direction trade societies could render effective services. Indeed, without their sympathy and hearty co-operation no system of industrial education can be effectively brought home to the artisan, and unless this is done, and effectively done, much of our educational efforts of the day will be little better than a dissipation of energy. Whatever scheme is founded it should be equally available for all industries. "In a general way it may safely be predicted that the nation which has the most varied industries is likely, all other things being equal, to be the most prosperous, powerful and contented." The success of our technical education will depend upon how it is applied in the interest of the young pupils or apprentices in the several branches of trades, rather than in the interest of older hands, who have discovered by experience the disadvantages of neglected education. Assistance in the latter case should not be withheld, but no substantial or permanent improvement can be made unless the career of the young mechanic is carefully guided at every stage, but especially at the apprenticeship stage.

We have already traced the altered relationship between the master mechanic and his pupil in consequence of our factory system, close competition, and division of labour, and it becomes a question of vital importance to ascertain how, under existing circumstances, to remedy the difficulties which our modern apprentices have to contend against in acquiring a practical knowledge of their trades. The concurrent testimony of all practical authorities is that the apprenticeship system cannot be superseded by any other form of education in trade, but that the difficulties which surround him in the whirl and push of our modern factory, render it all the more necessary that his wits should be sharpened, his observing powers cultivated, and

his mind stored with information applicable to his calling, before he enters the factory or workshop. Unfortunately masters as a rule fail to test the pupil's ability and qualifications, unless to serve some immediate and inferior purpose, and the pupil is left to work his way as best he can. This is a radical defect. Considering the number of educational advantages now available, masters would secure the most effective service of their apprentices, stimulate elementary education, and generally promote the improvement of the industrial arts, if they would refuse to admit any youth as an apprentice who had not made sufficient progress in the recognised Schools of Art, Science, and Technology;—certificates of competency being obtainable from all such schools, there could be no difficulty in applying this test. Trade societies having to a great measure assumed the duties of the old trade guilds, are now called upon in their own interest to see that the apprentices to the various trades are registered as properly qualified. Unless some technical certificate is required by trade societies from candidates for membership, the educational status of the artisan cannot be improved. One of the most honourable of the London companies, the Plumbers' Company, had a rule as old as the time of Edward III. to the effect that "No one of the trade of plumbers shall meddle with works touching said trade except by the assent of the best and most skilful men in the said trade testifying that he knows how well and lawfully to do his work, so that the said trade may not be scandalised or the community damaged by folks who do not know their trade."

The teaching of trades is what is rendered possible under the scheme of the Guilds of London Institute, and skilled workmen of any trade having qualified under the Institute can earn result fees by giving instruction in their respective trades. Practically, the adoption of this system is limited to towns where suitable accommodation can be provided in the shape of class-rooms, workshops, or demonstration rooms and fittings, as in the case of the Science Schools at the Belfast Working Men's Institute, which received aid from South Kensington towards fitting up the chemical laboratory, and the Technical School,

Hastings Street, which received aid from the London companies. The difficulty in forming trade schools in rural districts has been successfully overcome in the case of the Fishery Institute, at Baltimore, County Cork, where a school has been established for teaching boys "every art connected with fishing, from the making of lines and nets to the building of boats, curing of fish," &c. This has been established under the Industrial Schools Act, which will ensure an annual capitation grant from the State and a smaller sum from the county for each boy under instruction, and for the same purpose Grand Juries, or the Town Councils of Dublin, Limerick, or Cork, can obtain loans from the Crown at three and a half per cent. for altering, enlarging, building, or rebuilding industrial schools. There seems to be no reason why this Industrial Schools Act should not be extended to all properly constituted trade schools. Probably it would be if the zeal manifested in the case of Baltimore Fishery School was more general throughout the country. In Belfast, favoured by the existence of the Queen's College, which is sufficient to meet all the possible demands for high scientific education, what seems most required is a connecting link between the Science and Art Schools and the workshop and factory, so that the pupil or apprentice having entered the latter may be able to obtain that practical instruction by skilled workmen which there is no time to impart in the factory and no proper means of demonstrating in the lecture-room. For this purpose suitable workshops and apparatus will be required for all trades, and the teaching staff may be selected from the qualified teachers under the Guilds of London Institute, as at the school in Hastings Street, or they may be nominated by the respective trade societies interested in the welfare of their trade apprentices.

The Technical Schools of Huddersfield, Bradford, Nottingham, and Leeds, embrace the teaching of science and art as in our Government School and Working Men's Institute, and the teaching of technology as under the Guilds of London Institute, and in many cases aim at a still higher standard by endeavouring to accomplish in arts and medicine what is effectively done

by our Queen's College. We in Belfast may fairly leave the high cultivation of science and original research with the College, and content ourselves by the endeavour to utilise the provisions of the Science and Art Department and the Guilds of London Institute for the benefit of the industrial classes. While acknowledging the superior excellence of both organisations for the accomplishment of their intended purpose, there is a certain amount of incoherence about them that militates against their complete success. The Public Libraries Act was intended to remedy this defect, by placing in the hands of a permanent municipal authority funds for the promotion of popular technical education by the establishment of Libraries, Museums, and Schools of Music, Science and Art, and more effectively to apply such other funds as may be voluntarily placed in their hands for similar purposes. Many of the chief towns of the kingdom have utilised the powers of the Libraries Act with great effect, in exciting public interest in favour of technical education and raising noble buildings as appropriate homes for Literature, Art, and Science.

Belfast will probably have, under the powers of the Act, a municipal building architecturally equal to any, but to make it complete as a means of promoting technical education, it should embrace an economic museum and art gallery, and if external or voluntary aid will admit, it should provide class-room and workshop accommodation for the teaching of science, art, and technology, thus forming one central educational establishment or Victoria Institute, qualified to teach the principles and practice of science and art in their relation to our national industries, as successfully as the Queen's College prepares the students for the University. And if our wealthy merchants of Belfast would only strive to realise such a scheme this Jubilee year, it would go a great way towards stimulating the Government to provide for the Queen's College the additional accommodation for scientific demonstration which it has claimed so long and still so badly requires. Whether this can be accomplished or not, the central institution, even as an auxiliary to the Schools of Science, Art, and Trade cannot be

complete without a good economic and art gallery, in which our mineral and other national products should be exhibited, and their several uses in the arts illustrated, with the processes by which they are rendered available. In our industrial museum we should have selected examples of our home and foreign textile productions, patterns, processes, inventions, improvements, suggestions, and the combinations of industry that are being provided to meet the increasing requirements of advancing civilisation. Mr. Gray closed his lecture by describing the advantages that would arise from such a central institute not only to the Schools of Art, Science, and Technology, but to the public generally, and hoped that a strong effort would be made to have it established as a memorial of the Jubilee year.

At the close of the paper the Chairman invited discussion.

Mr. Young congratulated Mr. Gray on having treated his subject in an able and comprehensive manner, and expressed himself in favour of having a proper School of Technology and a Museum for Belfast. He did not think, however, that the building should be connected with the Library, but considered it would be much better in another part of the town.

Mr. Greenhill said that, at the suggestion of the Mayor, a committee had been formed for the purpose of carrying out the preliminary arrangements in connection with a Technology School, and adverted to the essayist's remarks in connection with apprentices, observing that he would much prefer the lad who got his training in a small shop, where his duties were of a varied character, to the apprentice in a large establishment, who was kept constantly at one class of work.

Mr. Carson complimented Mr. Gray on the excellence of his paper, and suggested that it should be published in pamphlet form.

Mr. Gray, in reply, said he would not like the Town Council to have the whole management of the school, but he would take advantage of the Council's power under the Libraries Act so as to render the School or Institute permanent by being conducted under the Council as the municipal authority.

They had been told that it would be unfortunate for it to be connected with the Town Council, inasmuch as they would be swamped with rates, but the Act providing a penny rate was passed for the purpose of limiting the rate to a penny, though of course he knew there had been efforts to make the rate twopence. He thought, however, that it would be unfortunate if they were permitted to tax the ratepayers in this way, because it would have the effect of checking voluntary efforts and contributions. With regard to having one building, he certainly would not go in for swamping all the others into one institution. His idea was to have a central building containing the necessary appliances for the other institutions which would gather round the museum, and that the municipal committee should be the directing authority, having their central building equipped with such appliances, apparatus, models, examples and diagrams, as may be necessary to aid and stimulate the efforts of any or all the schools or classes established throughout the town for the promotion of any form of Technical Education.

*9th March*, 188–

W. H. Patterson, Esq., M.R.I.A., President, in the Chair.

W. H. Hartland, Esq., C.E., read a Paper on

## SEWAGE DISPOSAL AND RIVER POLLUTION: ITS PRESENT AND FUTURE ASPECTS, FROM A SANITARY AND ECONOMIC POINT OF VIEW.

The Lecturer began by stating that probably no subject connected with the public welfare demands a closer or more philosophical inquiry than this. One of the first authorities of the day has recently made use of the words, "I am compelled to admit that the subject of sewage generally is in a frightful mess." The dangers to public health are almost infinite in number and character, and the legislative attempts to guard against them promise soon to become not alone a serious burden upon the pocket, but an irksome interference with the freedom of domestic life. Yet the chief dangers from sewage disposal are not, like those from bad food or drink or overcrowding, patent to all, and thus easily avoided. They are underground and out of sight, almost unknown, yet always active and ready to spring up and destroy us, whenever a favouring condition of circumstances may arise. What constitutes a satisfactory system of disposal? His reply would be this—Purify the sewage before putrefaction sets in; all the rest will follow as a matter of course. Providence, indeed, will do the rest in the shape of "aeration," for pure air no sooner meets with either foul odour, liquid, or matter than a struggle commences—it proceeds to purify them. In the right application of these principles it may be we shall find a revolution in the present methods of procedure, both of treatment and of

sewer construction. What is the present aspect of this question? In the last half century there has been literature on it wholesale, parliamentary commissions, blue books, reports without end, yet the upshot of all is found in Dr. Tidy's recent statement that the subject is in "a frightful mess."

The chief end of the Legislature has been to prevent river pollution, in order that rivers and streams may be restored to the public as sources of pure air, clean water, fish life, &c. But the opponents of legislation ask, "What is the use of further legislation, when the present is almost a dead letter from the difficulty and increasing expense of putting it into practice?" Let us examine the procedure that has led to this result. The first point to be noticed is engineering. There was generally some great scheme for the purpose of gathering up and concentrating in one stream the whole nuisance of a locality, and then passing it on to a neighbour. If anything illustrates the adage, "The farther you go the deeper the mire," it is sewage disposal on these terms. The next method of procedure was sewage farming. This was at one time looked upon as the grand solution of the problem. Although large sums of money have been expended in this way it is gradually being abandoned. Next, there is settlement and after filtration. Grave sanitary reasons soon showed the fallacy of filtering raw sewage, and the settling tank was brought into play. But the after filtration over areas of land involves numerous difficulties—a great deal of land is required, it soon gets "sick," and has to rest; yet if the land be of a suitable quality a step is made towards the economic use of sewage by the affinity of the filtering medium for the more volatile and valuable elements in the sewage, and the land has become manured; but the season for manure is limited, whilst that for sewage is constant, and we are compelled to go on "in season and out of season." The "pail system," with its handful of charcoal to arrest and to deodorise the volatile elements has a certain economic value, but is repulsive and can never be popular, and besides it leaves half the drainage of the towns, and that in point of fact the most

objectionable, untouched. The lecturer proceeded—We now come to what is termed the scientific or chemical treatment of sewage. It may be stated briefly that natural laws, applicable to liquid purification, are—First, subsidence ; second, natural oxidation ; third, the general laws of chemical affinity—with the latter is combined filtration. No matter how carried out, chemical treatment aims at accomplishing one or other of the effects natural to these laws. In precipitation or forced subsidence, the agent used is generally lime. In the oxidation of organic matter, permanganic acid, or salts of iron, we often used, either with sulphate of alumina, or with lime. The A B C, or alum, blood, and clay process, has been keenly fought over, and is yet in controversy. The new process at Southampton by which three grains of "very porous carbon" are added to each gallon of sewage, probably effects little more than a partial deodorisation of the liquid. Some other chemicals would seem to operate quite as much by bleaching, as by really purifying the sewage. But the bulk of these systems all aggravate the difficulty of the "sludge" or solid deposit from the sewage by adding, in the form of lime, alumina, or other ingredients, immensely to its bulk, and none of them are carried out except at great cost. The Birmingham Drainage Board, for instance, has £400,000 invested in works (not sewers), and the sewage treatment of London, in the manner proposed by Mr. Dibden, is estimated to cost annually £118,000 ; another system proposed, but not adopted there, contemplated an outlay of 3¼ millions and an annual expenditure of £198,000 ; whilst a third proposal went as far as 3¾ millions, and £219,000 of an annual expenditure. In attempting to describe the possible future aspect of sewage disposal I may be allowed a little latitude, but will avoid as far as possible merely theoretical conclusions. The main question depends on obtaining a system of purification that shall be of universal application. If in so doing we can minimise the cost, and so reduce the ratal burdens, we shall have accomplished something ; if we can obtain a cheap manure, we shall have benefited the largest industry in the country. I am not going to tell you that "Peruvian guano"

can be manufactured from sewage, but simply that an honest attempt can be made to recover that amount of natural value which sewage undoubtedly has. In former systems the more volatile and evanescent of these elements have been allowed to pass away, or have been simply neutralised. I would go farther —retain them. In the apparatus before me there are three, or indeed four, sections, for I propose to perform in detail what other systems do all together, and so fail to accomplish either. In the first section I apply the natural process which is to be seen at the mouth of the Blackstaff—*i.e.*, to allow the solid matter to settle by quiescence to the bottom. In the second section the liquid, freed from the grossest of this, flows between and through filter boxes filled with, let us say, coarse lime or chalk. These operate in a twofold manner—they serve both as a mechanical filter and as a chemical neutraliser for such acids as exist more or less in all sewage. In the third section the liquid, having gone through these preliminary stages of purification, falls to a lower level, one foot, or two or three feet, as the case may be, but falling by means of spray plates in a highly divided form through which a current of air passes. This is aeration, and is the system nature applies in every river or running stream. Then in the fourth section the highly aerated and oxidised liquid passes through a second series of filter boxes containing charred and earthy matter whose natural affinity for ammonia takes up more or less of this valuable constituent of manures. The final stage of this is subsidence, in the last tank, of all the remaining sediment, chiefly the finer organic particles. The fully purified effluent then passes away at any, even if necessary at a dead level—it is clear water, no longer sewage. Each part of the system is in duplicate, each may be of any convenient size, and any number can be placed side by side, so as to be applicable either to one central area, to a series of drainage areas scattered over one large town, or to a separate institution, workhouse, a hospital, or to a private house, or group of houses. The chief difficulty in all sewage questions has been the disposal of the "sludge." In the system I propose the sludge is not the manurial element in which I rely—for that purpose it may be

disregarded—the more valuable elements I have intercepted in another form. Nevertheless, the sludge remains to be disposed of. We will suppose that a commercial attempt is being made to utilise the value of the elements retained as manure; then the same fuel employed to create the aerating draft, to pump when necessary the low-level outfall and to work the filtering materials by grinding, &c, will also dry and calcine the sludge. The oxidised sludge is mixed with the coarse filtering materials by precipitating them into a drying floor or underground flue, which conveys the waste heat; here the material may lie undisturbed till dried. It may also be mixed with the ordinary town refuse, and the whole thus dried together, and once dry it can be treated as an ordinary raw material for manure, or more correctly as a vehicle for the reception of other valuable manure constituents, as in ordinary artificial manure industry. At the close of the lecture Mr. Hartland explained that owing to an accident to his experimental apparatus in transit from Glasgow, it had been necessary to effect some repairs, and they were only accomplished just before the lecture. He hoped, however, that the apparatus would be in full working order next morning, and anyone calling at the Museum after twelve o'clock would find it at work purifying the Belfast sewage.

A discussion, which was chiefly of a technical nature, followed, in which Rev. Robert Workman, Mr. Wm. Gray, Mr. J. J. Murphy, Mr. L. L. Macassey, C.E.; Professor Everett, Mr. E. N. Banks, C.E., and Mr. F. W. Lockwood took part. Mr. Hartland replied, and the meeting concluded.

*17th March*, 1887.

William H. Patterson, Esq., M.R.I.A., in the Chair.

Professor Letts read a Paper on

## FERMENTATION AND KINDRED PHENOMENA.

The subject which I have chosen for this lecture is one I may say of extraordinary interest and importance, not only in a purely scientific sense (though it has opened up several new fields of research), but equally if not more so from a practical point of view, as it deals with a wide range of subjects of much practical importance, and involves questions of the greatest moment to the whole human race. Among the latter there is a great deal that bears directly upon the causes, nature, and prevention of disease, and I feel that I may be charged with presumption for discussing this branch of the subject, which belongs more particularly to medicine and surgery; but my excuse must be that it is also very intimately connected with chemistry—in fact, its medical and chemical aspects are linked by the closest bonds, and I do not see how they can be discussed apart.

Let me first direct your attention to ordinary fermentation—the change which occurs in the manufacture of all spirituous beverages, such as wine, beer, whisky, &c.

Fermentation has been known from the earliest times. The art of wine making was attributed by the Egyptians to Osiris, by the Greeks to Bacchus, whilst as every one knows the Israelitish tradition assigns its discovery to Noah.

I suppose every one is aware how wine is made: that the grapes are crushed and the juice exposed to the air, when after some time a frothing occurs, and spirit gradually makes its

appearance in the juice, whilst in proportion its sweetness becomes lessened. Here we have a case of spontaneous fermentation, and the reason why wine-making is such an ancient process at once becomes apparent: for the first person who pressed out grape juice and allowed it to remain undisturbed for some time must have been the conscious or unconscious discoverer of fermentation.

But in the manufacture of other alcoholic beverages, such as beer, &c., the conditions are not so simple, for something must be added to the "sweet wort," or infusion of malt, to cause the fermentation, and that something is "yeast" or "barm."

Here let me at once say that in all cases of ordinary fermentation two things are necessary (1) a solution of sugar (2) yeast. I will explain presently why yeast is not *added* to grape juice, merely remarking that it is found abundantly in the juice after it has fermented.

I have here some sugar (not ordinary sugar, but the same sugar which exists in grape juice—hence called "grape" sugar) dissolved in water. To the mixture I have added some yeast, and the whole has been kept at about blood heat for some six hours.

You observe that the liquid is frothing, or "working" as it is called, and it is from that phenomenon that the term fermentation is deried [*fervere*—Lat. *to boil*]. Now this frothing is due to the escape of a gas (as was first noticed by Van Helmont) and that gas, as we can readily demonstrate, is carbonic acid.

I have here another experiment proceeding, namely, the distillation of some fermented sugar solution, to show you that spirit has actually been formed.

Now, as we took nothing originally but sugar and yeast, it is obvious that the spirit has been produced from them; and as at the end of the experiment we find the yeast in undiminished quantity, whereas some or the whole of the sugar has disappeared (according to the conditions of the experiment) it is obvious that the spirit and carbonic acid have come from the sugar. In fact it has been ascertained that the sugar is decomposed in

a perfectly definite manner, which we may represent by what is called a chemical equation, thus :—

$$\underset{\text{Grape Sugar.}}{C_6 H_{12} O_6} = \underset{\text{Carbonic Acid.}}{2\,CO_2} + \underset{\text{Spirit or Alcohol.}}{2\,C_2 H_6 O} \text{ *}$$

What has caused this change in the sugar? It must be apparent to you, I think, that it is the yeast (for nothing was present but the two things, and it can easily be proved that sugar will not ferment without the yeast). Then comes the question, and it is the very essence of the whole matter—What is the nature of the influence which the yeast exercises?

Loewenhoeck was the first to examine yeast under the microscope in 1680, and to find that it consists of very minute globules. Cagniard de Latour in the present century took up Loewenhoeck's work, which had almost been forgotten. "He observed that yeast consists of a mass of organic globules susceptible of reproducing themselves by means of buds which appeared to belong to the vegetable kingdom, and not to be simply organic or chemical matter, as supposed. He concluded that it is very probably by some effect of their vegetation that the globules of yeast disengage carbonic acid from the saccharine liquid and convert it into spirit."

The great German chemist Liebig took, however, a totally different view of the matter—a view which he can scarcely be said to have originated, as his ideas were almost identical with those of Willis and Stahl, chemists of the 17th century. His theory was as follows:—Yeast, and in general all animal and vegetable matters in a state of putrefaction, will communicate to other bodies the condition of decomposition in which they are themselves placed. The motion which is given to their own

* The chemist employs a kind of shorthand to represent the composition of substances and their decompositions and reactions. The "equation" in question indicates, first, the composition of the "molecule" or smallest particle of grape sugar capable of existence—the small indices showing how many atoms of the different elements it is composed of are present: "$C_6$" representing six atoms of carbon, "$H_{12}$" twelve atoms of hydrogen, "$O_6$" six atoms of oxygen. It also shows that the molecule of sugar is decomposed into two molecules of carbonic acid (each containing one atom of carbon and two atoms of oxygen) and two molecules of spirit (each containing two atoms of carbon, six of hydrogen, and one of oxygen). The term "equation" is employed because the number of atoms on each side of the = sign is the same.

elements by the disturbance of equilibrium is also communicated to the elements of the bodies which come into contact with them.

Then a third view was advocated by Berzelius and Mitscherlich, viz., that the yeast acts, as the chemist phrases it, "catalytically," that is to say, causes the decomposition of the sugar by its presence while it remains unchanged. This explanation is the more plausible as many such actions are known. For instance, the decomposition of bleaching powder into chloride of calcium and oxygen by peroxide of cobalt.

I do not wish to detain you longer with these historical particulars, nor can I follow out the chain of arguments which eventually led to the correct explanation of fermentation. It must be sufficient for me to state that Pasteur proved conclusively that the fermentation of sugar is inseparably connected with the life of the yeast cell; in fact, that the sugar is the soil or food upon which the yeast lives, and that the carbonic acid and spirit are waste products—just as the carbonic acid which is exhaled from our lungs is a waste product, the carbon being derived from the food we eat.

A few words as to the structure and life history of the yeast cell. When yeast is examined with the microscope under a rather high power it is found to consist of myriads of minute globules, which are round or oval. Careful investigation has shown that these globules or "cells" consist of a mass of protoplasm surrounded by cellulose. They are, in fact, paper bags full of protoplasm. The protoplasm, like the cellulose envelope, is colourless, sometimes homogeneous, sometimes composed of small granulations. In the protoplasm are usually seen one or two dots or "vacuoles," as they are called, which are cavities containing liquid. If the growing yeast cells are carefully watched under the microscope they are seen to alter their appearance with considerable rapidity. Sometimes at one, sometimes at two ends, small bladder-like prominences make their appearance, which gradually enlarge, and at last having attained a considerable size lessen in diameter at their base, and eventually separate themselves from the parent cell and lead an independent existence.

It is by this process of budding that yeast usually multiplies; but there is another method of reproduction which occurs only under special conditions. In this method we find definite seeds or spores produced *in* the cell. Spore formation occurs when yeast is deprived of nourishment and is exposed to a damp atmosphere. "Under these conditions the vegetative life of the yeast ceases suddenly, and in a few hours we see great changes take place in the protoplasm of the cells. The oldest and those which are poorest in protoplasm die and break up. While others grow larger, their lacunœ disappear and the protoplasm is diffused uniformly in the cellular juice. At the expiration of from 6 to 10 hours we notice the appearance in the midst of the protoplasm of from 2 to 4 small islets more brilliant and dense than the rest, around which fine granulations collect. These dense spots do not present any appearance of a nucleus, and they become differentiated more and more until they are exactly spherical; 12 to 24 hours later each becomes invested with a membrane, very thin at first, but which thickens by degrees. The spore is then ripe." These spores or "ascospores" as they are termed, are about $\frac{1}{3}$ the size of the mature yeast cell, and they have a much higher degree of vitality than the cell itself, and an infinitely greater power of resistance to destructive agencies. Thus they may be completely dried, and even exposed to a pretty high temperature, without losing their power of germination. They are, in fact, similar to the seeds of ordinary plants, and like many of these are distributed by the air. I think we may compare yeast with a bulbous plant, say a hyacinth, which at times reproduces itself by subdivision of the bulb, at others by the production of true seeds. Now, the ascospores of yeast are found in ordinary dust; and as grapes and other fruits are exposed for a long time during their growth to the atmosphere, a layer of dust collects on their surface and mixes with the juice when the fruit is crushed. Hence we can easily understand the spontaneous fermentation of grape juice and the juices of other fruits, such as those of apples and pears. Indeed, the spores of yeast have been found on the skin of the grape.

Let us return for a few moments to the process of fer-

mentation, as there are several points which deserve attention. We have seen that the yeast cell has the power of transforming sugar into spirit and carbonic acid. Are these the only changes it produces? Pasteur's elegant researches have shown the contrary. He has proved that other substances are always found in fermented liquids. One of these is glycerine, another succinic acid. Then we have a mixture of other bodies which are separated during the distillation of spirit, and are in chemical properties allied to that substance. The mixture is termed fusel oil.

The yeast cell is composed, as I have explained, of two parts essentially, viz., a bag or lining membrane of cellulose and an interior of protoplasm. During fermentation, yeast is constantly multiplying, so that its weight at the close of the operation is six or seven times greater than it was at the commencement. It is obvious that it must derive its nourishment from the fermenting liquid.

Pasteur showed by the most careful and convincing experiments that the cellulose envelope was derived directly from the sugar. We know, in fact, that a very close relationship exists between the two bodies, and that their mutual transformation is constantly occurring in the vegetable kingdom. But a difficulty arises as regards the protoplasm, for it contains nitrogen, and that element is absent from sugar.

Here again Pasteur has given the correct explanation, and has shown that yeast will not thrive for any length of time in a pure sugar solution, but requires for its nourishment certain salts and nitrogenous substances. These it finds in the juices of fruits or in malt infusion, but if fermentation is to be conducted with a pure sugar solution they must be added, at least if the fermentation is to continue.

Pasteur after various experiments succeeded in producing an artificial medium in which yeast grows luxuriantly. It contains in addition to water and sugar, tartrate of ammonium and yeast ash, or in place of the latter an artificial ash containing the same salts. We may compare with perfect propriety the ammonium tartrate and yeast ash to artificial manures, which are now used so extensively in agriculture.

Another very interesting point in the history of yeast was, I think, also first brought to light by Pasteur, viz.:—that the yeast cells when introduced into a liquid medium containing oxygen absorb that element with great rapidity, and develop a corresponding quantity of carbonic acid. This is a veritable respiration, exactly resembling the respiration of animals. Indeed, it has been proved that this respiratory act of yeast is as energetic, and even more so, than the respiration of fishes, which occurs in exactly the same manner, *i.e.*, by the absorption of dissolved oxygen from water. As fermentation can take place in a proper medium without free oxygen, Pasteur appears to have formed the theory that the fermenting character of the yeast cell is due to the power it possesses of breathing at the expense of the sugar, and that the latter's decomposition into carbonic acid and spirit is the consequence of the act by which the oxygen is removed from the sugar. In this case the latter must suffer a far more complex change than is usually supposed.

From all these considerations we see that yeast is a very simple form of plant life, the spores of which, owing to their minute size and lightness, are widely distributed. We also see that like other plants it requires a definite soil for its growth and nourishment, and also that in growing it gives rise to perfectly definite chemical products which are formed from the nutritive material, viz., sugar.

Does yeast stand by itself in these respects, or are there other ferments similar to it in general functions?

To this question science has given a very decided answer in the affirmative, and has shown beyond doubt that there are almost countless ferments in air, dust, and water, which, while resembling yeast in the nature of their functions, differ from it in several essential particulars. And this leads me to the second division of my subject, viz., the question of *spontaneous generation.*

I may introduce this part of my lecture by some extracts from an address by Professor Huxley given some years ago to the British Association.

"From the earliest times the doctrine prevailed that under

favourable conditions, of which putrefaction was one of the most important, animals could be produced without parents."

The ancients were deeply imbued with this idea, and we find it again and again discussed or spoken of in their writings; whilst in the Bible itself we find passages which evidently refer to it. Lucretius said—"With good reason the earth has gotten the name of mother, since all things are produced out of the earth, and many living creatures even now spring out of it, taking form by the rains and the heat of the sun." The great philosopher Aristotle maintained that every dry substance which becomes moist, and every moist substance which becomes dry, produces living creatures, provided it is fit for their nourishment. The famous riddle with which Samson perplexed the Philistines: "Out of the eater came forth meat, out of the strong came forth sweetness," evidently expressed the idea that the bees which Samson found in the carcass of the lion he had killed had been produced *out* of the carcass. Indeed, the idea that bees could be produced artificially from the dead bodies of animals was believed in implicitly by the ancients, and we find a complete description of the method to be adopted in the Georgics of Virgil!

It is not hard to understand how in primitive times insects appeared to be generated spontaneously from corrupting matter, but on the other hand it is very difficult to imagine how the notion could have originated that the higher animals could be produced artificially. That such a belief prevailed is certain, for we find Van Helmont, a chemist of the 16th century, giving directions for manufacturing mice, and he even went so far as to maintain that fish are produced out of water.

Even in contemporaneous times the notion of spontaneous generation has found plenty of supporters, and it is not many years ago since it was gravely announced that a new insect—the *acarus electricus* (for it was even christened!) had been produced by means of the electric current, and I have often been told in country places that if horse hairs are placed in water each separate hair will become an eel!

The first to combat the doctrine of spontaneous generation

was the Italian Redi, who, by a very simple experiment, proved that flies are not produced spontaneously from putrefying meat. He merely enclosed fresh meat in a gauze cage, and observed that although the latter putrefied no maggots nor flies were developed *in* it. He watched the flies hovering over the enclosed meat, and by a mistaken instinct depositing their eggs in the gauze cage, and eventually he saw these eggs turn into maggots. He thus proved, by an experiment which we may agree with Huxley in calling childishly simple, that insects *are* produced from their parents and not spontaneously as a product of corruption. Redi's experiments were sufficiently conclusive with regard to the mode of genesis of the higher animals, but after the construction of the microscope had been improved, when, in fact, the compound microscope came into use, the question of spontaneous generation was again brought prominently forward. For the microscope revealed countless organisms in ordinary water, but especially in infusion of animal and vegetable substances, such as meat broth and an infusion of hay. These organisms, or "infusoria," as they were called, are characterised by their extreme minuteness; hence the question of their origin presented considerable difficulties. If we examine an organic infusion recently prepared no sign of a living organism is visible, but in a few hours the liquid teems with myriads of minute beings. Whence have they come? Are they produced spontaneously from the animal or vegetable substances present in the infusion? or are they the descendants of pre-existing beings which have gained access to the infusion in some way, are they formed from eggs or spores present in the water or in the substances from which the infusions have been made? The English observer Needham was the first to attack this problem experimentally. He argued that as heat destroys both the seeds of plants and the eggs of animals a boiled infusion ought not to develope any living organisms. He tried the experiment, *i.e.*, he heated the infusions in hermetically closed vessels, and found that subsequently organisms *did* develope; hence he came to the conclusion that they were spontaneously produced. After these experiments the Italian physician

Spallanzani took up Needham's work, and by heating the hermetically sealed infusions for a longer period arrived at the opposite result—no infusoria appearing after the prolonged heating. Needham, however, was prepared with an argument to explain this result, his contention being that under the conditions of Spallanzani's experiment the *germinating power* of the infusion had been destroyed, and further that the air contained in the closed vessel had been destroyed by the heat. The latter part of this criticism acquired some force when it was discovered that the gases contained in vessels of preserved provisions contained no oxygen, and oxygen is, as we know, essential to life. Swann, however, showed conclusively that if an infusion previously boiled is placed in communication with air that has been heated red hot, no putrefaction occurs. Ure and Helmholz multiplied Swann's experiments with the same result, and Schulz found that instead of calcining the air it is sufficient before admitting it to the boiled infusions to allow it to pass through energetic chemical substances, such as oil of vitriol, &c. These experiments were really sufficient to decide the question against the doctrine of spontaneous generation, but its supporters were hard to defeat, and clung tenaciously to their belief. Their objection at this stage of the controversy was ingenious, if nothing else. By calcining the air, or by passing it through energetic chemical substances, you destroy some principle in it which is essential for the production of infusoria, they said. It is all very well to say that you merely destroy the seeds or germs, but you offer no proof of such a thing.

This criticism had to be met, and it was met most ingeniously by Schroeder and Dusch, the method which they employed being simply a refinement of Redi's experiment with the gauze cage round the meat.

Instead of the gauze cage they used cotton wool, merely allowing the air to filter through it before coming in contact with the well boiled infusion. Under these conditions they found that the latter remained perfectly sweet and fresh, showing no trace of organisms when examined under the microscope, nor the slightest symptom of putrefaction, except in the case of

milk and eggs. It is, they argued, difficult to imagine that the wool can have removed anything from the air except solid particles, and these must be the germs of the infusoria.

It only remained to demonstrate, first, that these germs are actually present in air, and secondly, that they are retained by the cotton wool. Independently Tyndall and Pasteur devoted themselves to this branch of the subject, and arrived at positive results by two totally different methods.

In Pasteur's beautiful researches, which are remarkable for their simplicity, elegance, and aptness, ordinary air was filtered through cotton wool, and as thus purified was found to have lost its power of inducing putrefaction in organic liquids. Pasteur then submitted the minute residue which was left to microscopic examination. In it he had no difficulty in recognising the spores of minute organisms; and to complete the proof that these spores are actually the seeds of putrefactive organisms he brought them into a previously boiled infusion, and found that in the course of a few hours the liquid was in active putrefaction. Tyndall's experiments were based upon totally different considerations. Every one knows that when a ray of sunlight enters a dark room its path is clearly visible. The ray looks like a faint luminous cloud, and if the cloud is examined narrowly myriads of particles are seen to be floating in it. Now, Tyndall found that by allowing air to remain perfectly quiet and undisturbed for a day or two these particles by their natural gravity subside, and a ray of light when now passed through the air no longer shows any visible track. He proved by a simple experiment that air before subsidence causes organic infusions to putrefy, whereas after subsidence the infusion may be exposed for any length of time to it without undergoing the slightest putrefactive change.

We may, therefore, consider it as definitely proved that putrefaction is caused by minute organisms, the spores of which are present in air, and that it is not due to any spontaneous change occurring in the putrescible matter, nor to any specific action of the air as such. The minute organisms are produced from spores or eggs, and the doctrine of spontaneous generation we may consider as finally refuted.

The study of the causes of putrefaction has opened up a very wide field of research, and has thrown a flood of light on many phenomena which were formerly hidden in mystery. For careful enquiry has shown that the spores and seeds of minute organisms are almost universally present,—that they occur abundantly in air, water, and earth. Only some of them are concerned in causing putrefaction ; others have equally well defined but totally different functions. Thus there is a set of organisms which have the power of inducing perfectly definite chemical changes in certain substances, and unconsciously they have been employed from time immemorial for the purpose. As an example we have the organism which causes the production of vinegar (acetic acid) from fermented liquids (which contain alcohol). Others again cause the production of various colouring matters, and some of these have not unfrequently excited the awe and wonder of the superstitious. For instance, there is the phenomenon of the "Bleeding Host," when bread has apparently become covered with blood. But far more important than any of these are the organisms which are undoubtedly associated in an intimate manner with certain diseases, often the very worst and most malignant to which men and animals are subject. I shall endeavour presently to show there are grounds for believing that in producing disease they are playing a chemical role, and it is by no means impossible that the chemical changes induced by them in the blood and secretions are the actual causes of the diseases in question. Before entering upon the discussion of some of these different organisms, which for our purpose we may arrange in four groups, viz. :—

(1) Putrefactive.
(2) Chemical.
(3) Chromogenic.
(4) Pathogenic.

I may be permitted to say a few words about their appearance,

life history, and the methods which have been invented for their study. The organisms in question are very numerous, and diverse in size and form. Naturalists have found much difficulty in assigning them to their proper kingdom ; and, in fact, from time to time have transferred them from one kingdom to another ; at one period considering them to be animals, at another vegetables. At any rate they are among the lowest types of life, and may be considered to be on the borderland between plants and animals ; but at last they have been definitely claimed by the botanists.

They have as a class been called by different names. Haeckel termed them "Protista," Sedillot "microbes," and they include besides the different varieties of yeasts, moulds, and fungi, the so called "splitting fungi" (*spalt pilze*) or "schizomycetes," in allusion to their peculiar mode of reproduction. These latter are of especial importance, and I shall in the rest of this lecture deal with them exclusively.

The classification of the schizomycetes has not yet been definitely settled. It will be sufficient for our purpose to describe the appearance of some of the chief varieties.

*Micrococci.*—Minute round organisms, sometimes arranged in groups of two (dumb-bells, *dyspsococci*), or of four (*tetrad*), or in packets of tetrads (*sarcinci*). Very frequently they are found in chains (*streptococci*).

*Bacteria* and *Bacilli.*—The first short, the second longer rods, often arranged in groups of two, or in chains of many. They are frequently motile, darting about with great rapidity. The movement is caused by a whip-like appendage *(flagellum)* attached to one end of the organism.

*Leptothrix.*—Long filaments, often branching out in different directions.

*Spirillum.*—Organisms which are twisted, often like a cork-screw, and which move with great rapidity.

*Modes of Reproduction.*—The schizomycetes, as I have before mentioned, are so called on account of their peculiar method of reproduction, *i.e.*, by splitting in one or more directions, each fragment becoming a mature organism and again sub-

dividing. As this mode of reproduction occurs very rapidly, the actual rate at which these organisms multiply is something truly startling, and fully accounts for the rapidity with which putrefaction and similar phenomena progress when they have once been set in action. Indeed, it reminds one of the fable of the man who offered to sell his horse for a price to be determined by the nails in its hoofs—½d. for the first nail, 1d. for the second, 2d. for the third, and so on. You may recollect that if there were in all 24 nails, the horse would have fetched £34,947 9s. 4d. According to Cohn, under favourable conditions a single bacterium by growth and division could produce in 48 hours the enormous number of 281,500,000,000 individuals! And this rate of development, if carried on for five days, would give sufficient bacteria to fill the ocean. Another estimate is that the progeny of one bacterium which in the course of 24 hours only weighs $\frac{1}{50}$ milligramme, at the end of three days amounts to 7,500 tons. In point of fact, perfectly favourable conditions for the continuous development of these organisms are never actually realised, or at all events for any length of time; for the rapidity of their multiplication is at once checked as soon as the soil (if I may use the expression) in which they grow begins to be exhausted, and is eventually entirely stopped owing to this cause. Moreover, it would appear as if the substances excreted by the organisms themselves, if not removed, or at all events diluted, act injuriously upon them, and eventually cause their destruction, or at all events the cessation of their functions; just as we find that yeast ceases to grow in a sugar solution when the spirit reaches a certain strength, the spirit paralysing or destroying the vitality of the yeast cells. A curious fact in connection with this statement is that in many cases the substances produced by minute organisms are amongst the most active agents for their destruction. I fancy that nearly all excrementitious products are peculiarly fatal to the health of plants and animals producing them.

Apart altogether from the process of multiplication by fission, we find another distinct method of reproduction among the *schizomycetes*, or at all events among some of them. This

method is very analogous to the *ascospore* formation of yeast, and is evidently a provision of Nature's for preventing the organisms from becoming extinct under conditions unfavourable for their ordinary life and development. In spore formation the contents of the cell contract, and eventually a round spore is produced within the cell, which finally escapes. The spore placed under favourable conditions eventually germinates into a mature organism.

The resisting power of the spores to the action of agencies fatal to the existence of the organism from which they were developed, or into which they grow, is very striking, and fully accounts for the difficulties experienced in disinfection, and also for many of the mistakes which were made by the believers in the doctrine of spontaneous generation in interpreting the results of their experiments. Again and again they declared that organisms made their appearance in liquids which had been thoroughly freed from them. No doubt the organisms themselves were absent, but their spores were present, not having been destroyed during the preparation of the infusion. Thus the bacillus of hay infusion may be boiled in water for ten minutes without losing its vitality, and it may be soaked in pure carbolic acid and in other strong disinfectants without losing its power of germination. The resistance of these permanent spores to agencies which easily destroy the life of the mature organisms with which they correspond is a point of great importance with regard to infectious and contagious diseases (or at least to some of them), but I hope to touch on this matter later on.

There is only one other consideration I shall mention in connection with the morphology of the schizomycetes, but it is of importance, and may considerably modify many of the present views. It has been asserted again and again—and I think the eminent surgeon Loeher was among the first to make the statement—that certain of these organisms under special conditions undergo a metamorphosis of such a kind that a micrococcus can become a bacterium, the bacterium a bacillus, the bacillus a leptothrix thread, or a spirillum, &c.: in short, that in certain

cases an organism can assume various forms. Zopf, in especial, has maintained the existence of this pleo-morphism, and his system of classification is very much based upon the assumption. In his book he gives drawings taken from actual observations illustrating transformations of this kind. The possibility of these changes occurring adds to the difficulties—already very great—which are experienced in investigating these organisms; for what means have we of classifying a particular species if it can exist in various forms and be of different sizes? It is obvious that mere microscopic examination and measurement, which have up to the present time been relied upon in establishing the identity of an organism, completely lose their value. Besides, another set of questions are also raised by this new doctrine, which I may be able to refer to when I come to the consideration of the pathogenic species.

Having explained, as far as time permits, these few points connected with the life-history of schizomycetes, you will permit me to say a few words next relative to the conditions under which they thrive. Their tissues contain much the same primary constituents as are found in ordinary plants and animals —that is to say, the elements Carbon, Hydrogen, Nitrogen, and Oxygen, and in addition certain mineral substances among which are Lime, Potash, Magnesia, and Phosphoric Acid.

The juices of meat and of vegetables contain the nutriment for these minute organisms in the most readily assimilable form, hence we find them especially suitable for their nourishment, and not only is this the case, but it has also been shown that the various secretions of animals such as blood, saliva, milk, &c., are capable of serving as soils, in which (certain species at least of) organisms thrive well. Some of them, though possibly their number is restricted, can be grown in artificial solutions, such as Pasteur's fluid, but I think it may be stated as a rule that the schizomycetes require for their nourishment more complicated compounds than those which can be prepared in the laboratory. I mean they require albuminoid bodies, of which ordinary white of egg is an example. In this respect they resemble animals and not vegetables, as the latter have the power

of manufacturing for themselves albuminoid bodies out of simple compounds. The schizomycetes then thrive in liquids containing the necessary materials for their growth, but they also frequently live on solids, such as potatoes, white of egg, &c. Oxygen (in the free state) is essential to the lives of some, but not of all.

It is necessary for me to say a few words about the methods which have been devised for cultivating organisms in the pure state, and indeed our present knowledge of most of the really important facts connected with them depends very much upon the introduction of accurate methods for the purpose. For if we consider for one moment that the spores of countless species swarm in the air, and are present, unless suitable precautions are taken, in water and in animal and vegetable matter, we can easily see that the isolation and cultivation of one particular species is a difficult task : for how exclude the others? An agriculturist would be puzzled to know how to raise a crop of corn without any weeds whatever if he were not permitted to remove the weeds as they appeared. The Bacteriologist is called upon to do this, but the weeding operation is denied him. How has this difficulty been overcome? It is evidently essential in the first place to have a soil suitable for the growth of the organism we want to cultivate, and this soil must be free from other organisms or their spores ; next, the organism we wish to cultivate, or its spore, must be introduced into the soil ; and thirdly, the soil and the organism (or its spore) must be placed under suitable conditions for the growth of the latter ; the experiment being so conducted that no adventitious organisms can make their entrance into the vessel in which the cultivation is proceeding.

We require then :—

(1) A suitable nourishing medium, which must be sterile (*i.e.*, free from organisms).

(2) The pure organism, free from other species.

(3) Suitable conditions as to temperature, &c., for the growth of the organism.

Now, in the laboratory various "soils" are made use of.

Beef tea, blood serum, infusions of turnip, cucumber, and other vegetables, Pasteur's solution, &c., and occasionally solids such as potatoes. But for the present we need only consider liquid media. When freshly prepared they usually swarm with organisms. This cannot be avoided; our only course is to destroy them. To do this the liquids are placed in suitable vessels (usually glass flasks or test tubes) the mouths of which are plugged with cotton wool. They are then heated to the temperature of boiling water, either by immersing them in steam or by boiling their contents. The heating is usually repeated on three consecutive days, so as to ensure the destruction not only of the organisms originally present as such, but also those which may have subsequently germinated from the more resisting spores. The liquids are now sterile, and no organisms can gain admission to them so long as the plug of cotton wool remains undisturbed. To prove the sterility, the liquids ought to be kept for some time, and should show no cloudiness or other evidence of change. We have next to introduce an organism or spore of the particular species we wish to cultivate, *free from any others of a different species.*

To do this was, for some time, an impossibility, for how pick out a single individual when to see it requires the highest powers of the microscope? We are indebted mainly to Koch for having solved this problem, and for having devised a beautiful and ingenious method which has marked quite an epoch in bacteriological science.

Koch takes a sterile nourishing medium containing gelatine, which when cold solidifies to a jelly.* He then introduces into the gently-warmed medium a droplet of liquid containing the organisms to be cultivated (but presumably other organisms also) and pours the mixture upon a glass plate which has been previously heated to a high temperature to destroy any organisms present in the dust on its surface. The plate is then put beneath a bell-shaped jar on blotting paper previously soaked in corrosive sublimate solution. By this means the jelly is kept moist, and at the same time protected from dust.

* Probably everyone knows that ordinary jellies "set" on account of the gelatine which they contain.

Consider the effect of this operation. The organisms present in the liquid with which the gelatine was inoculated are presumably equally distributed, and if only a few are present (which can be ensured by diluting the liquid used for inoculating) each individual is separated from another by a considerable space.

In course of time (only a few hours under favourable conditions) each organism reproduces itself, eventually producing a colony, and this colony *liquefies* the gelatine at a particular spot or causes an opacity. Hence we may be certain that liquid taken from this spot contains only one species of organism, and with this we can inoculate our sterile liquid and so obtain a pure culture. This beautiful method of Koch's has been employed by him for isolating and investigating many of the organisms of disease, and can be used for measuring the number of organisms in air, water, and other fluids.

Now, having inoculated our nourishing medium with the organism we wish to study, we have next to place it under favourable conditions for their growth, and as a rule that means a steady temperature (on an average about as high as that of our bodies). The apparatus used is called an "incubator," and is simply a box with double walls, the interspace being filled with water which is kept at a constant temperature by a gas flame, automatically controlled by a "thermostat," so that the temperature inside the box (where the culture is kept) never varies by more than a few degrees.

*        *        *        *        *        *        *

Such in a few words are the chief methods employed in "bacteriological" research, and with their introduction more

exact information has been obtained of many phenomena which previously were utterly obscure. Some of these phenomena I propose to examine.

*Putrefaction.*—This may be considered to be a beautiful device of nature's for disposing of dead organic matter, and for converting it into substances which can again serve for the nourishment of plants and animals. But for it this earth would be a vast charnel-house; we should be surrounded by the emblems of death, and not only so, but as the supply of substances suitable for the nourishment of plants and animals is limited, each race would gradually diminish the stock, which would eventually become exhausted and the world no longer habitable. As it is, however, no sooner does a plant or animal die or give up its excretions, than the remains are fastened upon by an army of scavengers, who gradually reduce them to simple compounds which are either dissipated in the air, washed away by water, or go to form earth. Every tyro in chemistry knows that every atom of matter is indestructible, "and in its time plays many parts."

Our army of scavengers are mainly organisms of the kind I have been describing, and although much has been done towards their study, much still remains to be done before we shall be able to say definitely what their exact functions are. Thus we do not know at present how many species there may be engaged in the work, nor do we know with any exactness how each species acts. It would appear, however, that putrefaction is by no means a simple process, and that before a complex substance like albumen or white of egg can be resolved into simple bodies like ammonia, water, and carbonic acid it has to be attacked by successive gangs of these minute labourers, each gang dying off after completing its share of the work and leaving things in order for the operations of the next.

If any putrefying substance is examined with the microscope, it is found to be swarming with organisms of nearly all the forms I have described, viz., *micrococci*, *bacteria*, *bacilli*, *spirilla*, *&c.*

Hauser has devoted much time to the study of putrefactive

organisms, and believes that two species are especially active, at all events in the earlier stages of the process. These he terms *proteus mirabilis* and *proteus vulgaris* respectively. They are remarkable for the variety of forms they can assume, and furnish an excellent example of *pleomorphism*. Hauser has illustrated his work on the subject with some very beautiful micro-photographs (taken from nature) of these organisms in their various stages of existence.

Many interesting and highly important observations have been made with regard to the nature of the substances produced during putrefaction. Thus it has been shown by Selmi and others that putrefying animal matter frequently contains certain substances closely resembling in their properties some of the most poisonous alkaloids found in the vegetable kingdom. These have been called *Ptomaines*, and their significance is very great when we consider that in certain cases of suspected poisoning, corpses are often exhumed and are examined for alkaloids among other poisons. It is by no means impossible that a ptomaine might be mistaken for a poisonous alkaloid, and thus a false suspicion or even conviction arise as to the cause of death.

Again, many cases of poisoning have occurred from the consumption of tainted meat, fish, cheese, &c. In such cases it is also possible that the poisonous principles are ptomaines. It has also been shown that " by the putrefaction of animal substances a body can be obtained—the septic poison or *sepsine*—which is isolated by various chemical processes destructive of every living organism, and which on injection into the vascular system of animals, especally dogs, in sufficient quantities occasions a marked febrile rise of temperature, and is capable of causing death." *

*Organisms causing definite chemical changes.*—It is conceivable that every species of micro-organisms induces perfectly definite chemical changes in the medium in which it thrives. There are, however, certain species which induce very simple chemical reactions, and many of the latter are every-day

* Klein.

phenomena which have long been noticed and even employed practically, although their cause was not understood. A few of these changes deserve our attention.

*The Lactic Ferment.*—Everyone knows that when milk is kept it becomes sour and curdles.

As early as 1780 the Swedish chemist Scheele extracted from sour milk a peculiar acid, which he named from its occurrence lactic acid. It is obvious that the souring of milk is due to the development of this acid; but the question arises—From what special substance in the milk is it formed, and what is the cause of its development?

Careful experiments have completely answered these questions. One of the chief constituents of milk is sugar, not exactly the same as occurs in the sugar cane, but one which is very analogous. This "milk sugar," as it is called, is extracted from the whey of milk (chiefly in Switzerland), and is a commercial product. Now it has been found that in proportion as milk becomes sour the quantity of this sugar diminishes, and under suitable conditions it disappears altogether. Further, if a solution of sugar is mixed with a few drops of sour milk, the sugar solution becomes sour and the acidity increases rapidly. It is, therefore, pretty clear that the development of lactic acid in milk is due to some transformation which the sugar suffers, and we have only to compare the formulæ of the two to see that a simple chemical relationship exists between them. In fact, every particle of sugar contains the necessary atoms to form two particles of lactic acid, and we may represent the conversion of the former into the latter by the following chemical equation:

$$\underset{\text{Sugar.}}{C_9H_{12}O_6} = \underset{\text{Lactic Acid.}}{2\,C_3H_6O_3}$$

But what is the cause of this transformation? Pasteur, guided by his previous researches in alcoholic fermentation, sought for and found the lactic ferment which consists of minute rods or *bacilli*, which are often jointed or beaded. They can readily be seen in a droplet of sour milk with a $\frac{1}{4}$ inch power. By removing some of them from sour milk, and sowing them in a suitable

saccharine medium, he saw them multiply and produce all the effects of the lactic fermentation. As milk does not sour if taken from the cow in such a manner that no dust or solid particles can fall into it, there can be no question that its souring is due to the introduction of the spores of the ferment from dust or air.

*The Butyric Ferment.*—In a sugar solution which is undergoing lactic fermentation there is commonly developed, especially towards the close of the operation, another acid, which from its occurrence in rancid butter is called butyric acid. Pasteur investigated the causes of its production, and found that here again a minute organized ferment was at work, causing sugar to undergo a perfectly definite decomposition into butyric and carbonic acids and hydrogen gas. The change may be represented by the following equation :—

$$\underset{\text{Sugar.}}{C_6 H_{12} O_6} = \underset{\text{Butyric Acid.}}{C_4 H_8 O_2} + \underset{\text{Carbonic Acid.}}{2\, CO_2} + \underset{\text{Hydrogen.}}{H_2}$$

This change is remarkable on account of the hydrogen which is produced, for I do not think there is any other instance known in which it is formed under the influence of a living vegetable organism. Advantage is taken of the circumstance in dyeing wool and cloth with indigo, the dyer employing a vat containing indigo diffused in water and a coarse kind of wheaten flour or bran. The starch which the latter contains is first transformed into sugar, which is eventually decomposed by the butyric ferment, and the hydrogen which is liberated converts the indigo into a colourless soluble substance which is readily absorbed by the wool, but which is again converted into the indigo and precipitated within the fibre when the wool is exposed to air. I may mention that sugar is not the only substance upon which the ferment acts, for it will also decompose tartaric, mucic, and malic acids, and convert them into butyric acid.

The butyric ferment resembles the lactic ferment in appearance, consisting of rods or *bacilli.*

The fact that sugar is capable of fermenting in three different ways, and that these fermentations occur spontaneously, leads

us to enquire why in grape juice alcoholic fermentation always occurs, whilst in milk we seldom if ever find the yeast organism, but always that of the lactic or butyric fermentation. Both liquids contain sugar, yet each undergoes a different fermentative change.

A little reflection will, however, enable us to understand the reason. We must remember that other things besides sugar are necessary for the proper growth of yeast, the lactic and butyric ferments. Thus we have seen that yeast requires certain mineral matters, and also certain nitrogenous substances, for its development, and it is the same with the lactic and butyric ferments.

We know that certain plants thrive best in particular soils and often become self-sown : thus the common sea pink flourishes in the immediate neighbourhood of the sea, but is not found inland. There is probably some peculiarity of the soil of seaside localities which fit it especially for the nourishment of that plant. In a precisely similar manner grape juice appears to be the liquid most suitable for the yeast organism, whilst milk probably contains those mineral and nitrogenous substances which are essential for the nourishment of the lactic and butyric ferments.

*The Acetic Ferment.*—I suppose that everyone knows that beer and wine when exposed to the air become sour, in fact produce vinegar, which is manufactured commercially by this very process. In proportion as the spirituous liquid grows acid it is found to lose spirit ; hence it is obvious that the acid is produced from the spirit. The chemical name for the acid which is formed is acetic acid (from the Latin *acetum*, vinegar), and it is an elementary fact in chemistry that it can be produced by the oxidation of spirit. Thus

$$\underset{\text{Spirit.}}{C_2H_6O} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Water.}}{H_2O} + \underset{\text{Acetic Acid.}}{C_2H_4O_2}$$

It was originally believed that vinegar was produced by the simple chemical action of the oxygen of the air upon the spirit, and it was considered that the action was especially induced by porous bodies, which acted first as spongy platinum does, by condensing the oxygen and thus bringing it into closer contact

with the spirit. Pasteur has proved, however, that the determining cause of the oxidation is a definite ferment which has received the name of *mycoderma aceti*. It consists of minute rods or chains of rods, which often become felted together, forming a membrane somewhat like moist paper pulp to the naked eye, and this membrane is frequently found on the surface of the acidifying liquor, and is called the "mother of vinegar," or simply the "vinegar plant." Pasteur proved that the change of spirit into vinegar is really caused by the action of this ferment—and not by the simple action of the air—by a very elegant experiment. He allowed weak spirit to trickle down string (which is of course highly porous), and showed that in spite of its porosity no oxidation occurred, even after a month. He then steeped the cord in a liquid containing a pellicle of the mycoderma, some of which adhered to it, and then as before allowed the spirit to trickle down it, when it was rapidly acetified.

The manufacture of vinegar is carried out at Orleans in accordance with Pasteur's discoveries, the ferment being sown on the surface of the wine or beer. When the surface is covered with the membrane, the alcohol begins to acetify. From time to time fresh wine or beer is added, and when the acetification has terminated the membrane is collected, washed, and employed for a new operation.

I have not sufficient time to describe all the organisms which are capable of producing definite and well ascertained chemical reactions, and can merely mention one or two others. The ammonia ferment, which has the power of producing ammonia or hartshorn from urea, a substance abundantly excreted from carnivorous animals.

The nitre ferment, present in soil which oxidises ammonia to nitric acid.

The glycerine-ethyl ferment, which converts glycerine into spirit, &c.

*Organisms causing the production of colouring matters.*—Certain organisms belonging to the group of schizomycetes have the property of producing definite colouring matters,

either in their own tissues or in the medium upon which they grow. At times the sudden and spontaneous appearance of these organisms has created much wonder and awe. Thus, in 1819, "a peasant at Liguara, near Padua, was terrified by the sight of blood stains scattered over some polenta which had been made and shut up in a cupboard on the previous evening. Next day similar patches appeared on the bread, meat, and other articles of food in the same cupboard. It was naturally regarded as a miracle and a warning from heaven until the case had been submitted to a Paduan naturalist." *

The cause was found to be due to a minute organism to which the name *micrococcus prodigiosus* was given. It has been found in milk, paste, and even sacramental bread, where its appearance was of course considered miraculous. The colouring matter is not contained in the organism itself, but is produced by it in the medium in which it thrives. It somewhat resembles aniline red (magenta or rosaniline) in its properties.

*Red Snow* and *Blood Rain* are probably due to the same or to a similar organism. At times milk is found to be quite blue—a phenomenon of frequent occurrence on the German coast of the Baltic. Formerly it was attributed either to a diseased condition of the cow or to its consumption of vegetables containing indigo. Fuchs, however, showed that it was caused by an organism to which the name of *bacillus cyanogenus* was given.

Many other colour-producing organisms have been discovered, of which the following may be mentioned :—

*Bacterium synxanthum*, in yellow milk.

*Micrococcus aurantiacus*, occasioning orange patches at times on cooked vegetables.

*Micrococcus chlorinus*, producing green patches occasionally on cooked vegetables.

*Micrococcus violaceus*, &c.

Any one can obtain these organisms (or at least some of them) by exposing slices of potato (cut from potatoes well boiled in their skins) for an hour or two to the air, and then preserving

* Troussart. Microbes, moulds, &c.

them under glass bell jars (ordinary propagating glasses do admirably) on blotting paper moistened with weak corrosive sublimate solution. The spores of the organisms are deposited from the air on the potato slices, and after a few days develop into coloured particles or colonies which rapidly increase in size.

*Organisms of Disease.*—I come now to perhaps the most interesting and important part of my subject, viz:—to the connection which exists between certain organisms and some of the most serious diseases to which men and animals are prone.

That such a connection does exist has, I think, been very clearly and definitely established, and the question which now presents itself to medical men is not so much, are any diseases caused by organisms? but rather what diseases are not caused by them? I shall endeavour as briefly as possible to explain the facts and arguments which have led scientific men to the conclusion that certain diseases are caused by the introduction into the system, and subsequent development, and rapid multiplication of particular species of the schizomycetes.

I believe that the first observation tending in this direction was made by two French doctors, Messrs. Rayer and Davaine, to the effect that the blood of animals dead of splenic fever teems with minute rod-like bodies resembling the bacilli found in hay infusion.

This disease is one of the most deadly of those which are incidental to live stock, either sheep or oxen, and is remarkable for the suddenness of its appearance, and the rapidity of its action. A day or two, or in many cases only a few hours elapse from the time of its first symptoms to the fatal termination. Man at times is subject to it—especially those who are engaged in handling raw wool—whence the name "wool sorter's disease," or "malignant pustule" as it is also called.

Rayer and Davaine made their observation in 1851, but at the time they do not appear to have laid any great stress on it. It was subsequently confirmed in Germany in 1857, by Pollender and Brauell. At that time, however, the entire subject of micro-organisms was in its infancy, their nature and effects were not understood, and no doubt it would have appeared

ludicrous to assume for a moment that a minute organism, quite invisible to the naked eye, could attack and slay in a few hours a huge animal like an ox. But after Pasteur's memorable researches in 1861, on the ferment of sour milk, it was clearly shown that in spite of their minuteness, micro-organisms can produce very marked and extensive effects, even in a large quantity of matter, and Pasteur's work impressed Davaine so strongly with the potency of micro-organisms, that he once more returned to his observations of 1851, and became impressed with the belief that the bacilli observed in the blood of animals dead of splenic fever were no mere accidental accompaniments of the disease, but its actual cause.

The hypothesis having been introduced that this particular disease was really the work of micro-organisms, it was only natural that they should be sought for in other ailments of a similar kind, and the result has been a very distinct and important gain to medical science. It is possible that the new theory has fascinated medical men too much, and that they have too readily convinced themselves that diseases of all kinds are caused by organisms. It must, however, be borne in mind that investigations into the cause of disease are extremely difficult, and that the results are at times extremely uncertain and misleading. I think you will very naturally feel inclined to make this remark—of course I mean if you are not acquainted with the subject.

It is all very well to say that splenic fever is caused by organisms because they are found in the blood of the animals dead of the disease, but are not organisms almost universally present, and may not their occurrence in the blood of the animals be rather the effect than the cause? Do not they appear simply because putrefaction (or some modification of it) has already commenced?

The question is perfectly fair and logical, and has probably occurred to every one who has thought about the subject. Something more must indeed be shown besides the mere fact of the presence of organisms in the blood or tissues of an animal dead of the disease. In fact before we can credit so startling a

statement that the disease is caused by the organisms, we must be shown a most convincing and complete chain of proofs.

Such a chain of complete proof seems to have been established. As regards splenic fever, it is somewhat as follows :—

1st. We always observe in the blood and tissues of animals suffering from the disease, rod-like organisms or bacilli.

2nd. It is possible to inoculate (with every precaution) an artificial nourishing medium—say nutrient gelatine—with this blood, and we find characteristic colonies from which we can obtain a pure culture of the bacillus, with which we can inoculate a sterile nourishing fluid like broth.

3rd. On injecting this broth into a healthy animal—a mouse, a guinea pig, a sheep, or an ox, we find after a short interval all the characteristics of splenic fever. The animal usually dies, and in its blood are found countless bacilli of the kind from which we originally started.

The argument appears complete, and I believe that Koch was the first to maintain that no organism could be considered as the cause of a disease, unless all the above conditions are fulfilled.

Koch has formulated the above conditions, thus—

(1) It is absolutely necessary that the micro-organisms in question be present in the blood or diseased tissues of man or animal suffering or dead from the disease. [In this respect great differences exist, for in some infectious diseases the micro-organisms, although absent in the blood are present in the diseased tissues, whilst in others they are present in large numbers in the blood only, or in the lymphatics only—Klein.]

(2) It is necessary to take these organisms from their nidus—from the blood or tissues as the case may be—to cultivate them artificially, *i.e.* outside the animal body, but by such methods as exclude the accidental introduction into these media of other micro-organisms; to go on cultivating them from one cultivation to another, for several successive generations, in order to obtain them free from every kind of matter derived from the animal body from which they have been taken in the first instance.

(3) After having thus cultivated the micro-organisms, it is necessary to re-introduce them into the body of a healthy

animal susceptible to the disease, and in this way to show that the animal becomes affected with the same disease as the one from which the organisms were originally derived.

(4) It is necessary that in this so affected new animal the same micro-organisms should again be found. "A particular organism may be the cause of a particular disease, but, that really and unmistakably it is so can only be inferred with certainty when every one of the above conditions are fulfilled." (Klein.)

You will allow me to glance for a few moments at some of the most important diseases which have been thus shown to be intimately associated with micro-organisms.

*Tuberculosis.*—This terrible disease, of which so many sufferers die a lingering death, was proved by Koch to be due to a particular species of rod-like organism, which is called in consequence *bacillus tuberculosis.* They are a great deal shorter and thinner than the bacilli of spleen fever. Koch showed that they occur in all tubercular growths of men, monkeys, cattle, birds, and other animals, and in man they are found in the blood and sputum. It is possible to cultivate them in an artificial nutrient medium, best in solid blood serum; and the disease can be communicated to a healthy animal by injecting such a culture into its system. In guinea-pigs and rabbits the disease requires a period of "incubation" of three weeks and more; that is to say, this period intervenes between the time of inoculation and the first symptoms of the disease. It has been shown by inhalation and feeding experiments that animals can be inoculated; and as the bacilli themselves require a high temperature for their development it is probable that the disease is spread either by the inhalation of the spores or by their being swallowed with the food.

*Cholera* is one of the most dreaded of all diseases. Fearful for the wholesale slaughter it causes when a locality is once, so to speak, in its grasp, and fearful also for the terrible rapidity of its action. It is said to originate in the valley of the Ganges, where it is permanent or endemic, and yearly it spreads over India. In Europe it first appeared at the commencement of

the present century, since when there have been six visitations. The first indications that cholera is caused by an organism were the result of the researches of the French and German commission sent to Alexandria in 1883 to investigate the disease. Koch, a member of the German commission, discovered it, and called it the "comma" bacillus, from its peculiar curved shape. The bacillus is found in the intestine, but not in the blood ; it can be cultivated on nutrient gelatine, and Koch has observed that it readily multiplies in most articles of food, and even in damp linen. It requires a fairly high temperature for favourable development, but cold does not kill it. Koch also found the organism in the stagnant waters of certain cholera-stricken districts, and also in a tank, the water from which had apparently produced the disease in several people who had used it for drinking purposes. As soon as the bacilli disappeared from the water, cholera cases ceased.

I believe that there is still some doubt as to this organism being the cause of the disease, as inoculation experiments have only been of very doubtful success. It has been asserted that cholera has been communicated experimentally to guinea-pigs ; but others have maintained that these animals did not show the typical symptoms. Bochefontaine, of Paris, swallowed pills containing choleraic matter ; but although he felt unwell for some days no serious symptoms arose.

Many other diseases are believed to be due to organisms, and of these I may enumerate the following :—

| *Name of Disease.* | *Nature of the Organism.* |
|---|---|
| Diptheria | Micrococcus |
| Erysipelas | " |
| Pneumonia | Bacteria |
| Leprosy | Bacillus |
| Glanders | |

*Organisms present in the system in health.*—As the air we inhale, the food we eat, and the water we drink, usually teem with organisms, we are constantly introducing myriads of these minute beings into our systems. Indeed, Miquel estimates the number of spores introduced into the mouth at 300,000 a day! The fact would lose some, at least, of its repugnance if we were assured that when once introduced they would perish, but such is not the case, as any one can see for himself by examining a droplet of saliva under the microscope, when it will be found to swarm with all kinds of organisms, micrococci, bacilli, spirilla, leptothrix, &c. In fact the entire track of the alimentary canal appears to be a kind of garden in which organisms find a suitable soil for their growth and development. It has even been asserted that certain species aid in the processes occurring within our bodies, and assist digestion, &c. Thus we are surrounded by an invisible host of organisms, some deadly, some possibly of service to us. We offer admittance to all, but we expect the deadly not to enter, and broadly speaking we are immune from them. The doctor can enter a fever ward without infection. A family may breathe the same air and only one of its members is stricken with consumption. A Sister Dora (and for that matter many a physician whose name we never hear of) can suck a tracheotomy tube, and yet without catching diphtheria. We are almost confident now that in each of these cases a disease organism enters the systems of all concerned. "Two women shall be grinding at the mill, one shall be taken, and the other shall be left." At present I believe no satisfactory explanation can be given of immunity.

Let me return for a moment to the organisms present in the mouth. Adhering to the teeth are always to be found thread-like organisms called *leptothrix buccalis*. They are supposed to cause the decay of teeth, and there can be no doubt that microscopic examination shows that the decayed parts are full of organisms. Another very singular fact connected with the organisms found in the mouth, is that very often virulent species are present, that is to say human saliva when injected into healthy animals, such as rabbits, produces grave affections often terminating in

death. The blood of the animals thus infected is full of micrococci, and these can be cultivated by the ordinary methods. The virulence of saliva differs considerably in different individuals.

*Action of disease organisms.*—Many questions arise from the discovery of the connection between organisms and disease, especially regarding the nature of their action upon the system. It has been definitely proved, as I have explained, that many species produce in the nourishing medium definite chemical substances, some of which are excessively poisonous. Are the diseases which are believed to be caused by organisms due to the production of such poisons within the body; or are the blood and other secretions so altered in the nature as to be unfit for the proper performance of their functions; or are the diseases caused by a merely mechanical action of the organisms in plugging the minute blood vessels, and thus interfering with circulation? In fact, do the organisms act chemically or mechanically?

I do not see how these questions can be definitely answered until the chemist submits them to a very searching experimental enquiry. He ought, in the first place, to investigate the chemical action of each disease organism; to grow them in various nutrient media, and to investigate the nature of the substances they give rise to in each case. If such substances, when freed from the organisms which produce them, are found, when injected into healthy animals, to cause similar effects to those produced by the diseases themselves, the question will be decided.

There is an indication at least, if nothing more, that in certain diseases it is the virus produced by the organism which acts, and not the organism itself. Thus in spleen fever it often happens that death is so rapid that only few bacilli occur in the blood—quite too few either to cause the plugging of the small vessels or to remove the oxygen from the blood, and thus to deprive the system of that element.

*Recovery from disease.*—Another question which presents itself to our minds is this—How is it that if an infectious disease

is caused by organisms, and such organisms we know can be cultivated for any length of time in a suitable nourishing medium outside the body (provided it is renewed from time to time); how is it, I say, that we ever get rid of the disease? For our blood and tissues are constantly being renewed; a suitable pabulum is thus maintained for the continued growth of the disease organisms, and therefore it would seem that when once introduced they should continue to exist and never be got rid of. But we know that the contrary is the case, at least as a rule. Either the patient dies or recovers (quickly very often) and loses all trace of the malady. How can his recovery be accounted for?

The explanation may be as follows:—We know that organisms multiply very quickly in a suitable medium, and that the substances they produce are in many cases singularly antagonistic to their existence. The yeast cell is killed when immersed in a solution of spirit of a certain strength, and indol, skatol, and phenol, bodies which are produced by certain putrefactive organisms, are among the most powerful agents in *arresting* putrefaction. Therefore it is not impossible that the disappearance of an infectious disease and the recovery of the patient may be due to some such action: the organisms causing the disease multiplying rapidly up to a certain point, until, in fact, they have produced so much of their peculiar virus that it reacts upon themselves, and poisons off the whole crop.

But there is another explanation which is perhaps more satisfactory. We know that organisms require certain definite substances for their nourishment, and that therefore they thrive in a culture fluid only so long as these substances are present. Let us suppose that in the tissues of a healthy individual, a small quantity only of one of these principles is present: he catches an infectious disease, organisms are produced in abundance in his system, and rapidly use up this small quantity, then it is exhausted, the organisms no longer thrive, and eventually perish. It may be that a very long time will elapse before the convalescent can again accumulate the particular principle which

the organisms have used up, and during that period he will suffer immunity from the same disease. This, as every one knows, is very often the case.

*Protection from disease.*—Another question presents itself to us, and perhaps it is the most important, from a practical point of view, of any we have discussed. It is as follows :—

Granted that infectious diseases are caused by organisms, then, surely as we know what is required for their nourishment, and what is antagonistic to their existence, we ought to be able to devise some means for preventing their ravages among men and animals. An answer in the affirmative to part of this question was (to a certain extent) anticipated long ago, though unconsciously, by the introduction of vaccination as a preventive of smallpox. Perhaps few people know how ancient this operation is, for it appears to have been known to the Arabs and Chinese as early as the 10th century, and was also practised in India by the Brahmins, a public crier announcing that he had smallpox virus to sell. It was introduced into England I may say accidentally in George the First's reign.

The principle of vaccination is to give (by inoculation) a mild type of small-pox, which has the effect either of rendering the individual vaccinated entirely secure from an accidental attack of the malady, or in case he does take the disease to very materially moderate its violence. To Pasteur belongs the triumph of having proved that the vaccination method can be extended to other diseases incidental not only to man but to animals also. Thus with spleen fever or anthrax he prepares vaccine matter by cultivating the bacillus in an artificial medium for a considerable time at a high temperature. By this means it becomes "attenuated."

"At the end of a week the culture which at first killed the whole of ten sheep which had been inoculated with it, now only killed four or five, and in ten to twelve days it ceased to kill any—merely giving them a mild form of the disease and protecting them from further attack"—proved by inoculating them with the virulent virus. "The vaccine thus obtained in

Pasteur's laboratory is now distributed throughout the world, and has already saved numerous flocks from almost certain extinction."* Pasteur proceeded in a precisely similar manner in preparing a vaccine for fowl cholera—a very fatal disease incidental to poultry. Another method for preparing a vaccine fluid for various diseases, consists, so to speak, in passing the disease in question from one species of animal to another; the second species (in certain cases) taking only a slight illness, and then becoming protected against the virulent form. "Thus while the bacillus (from the blood) of sheep or cattle dead of anthrax invariably produces death when inoculated into sheep or cattle, after passing through white mice loses its virulence for those animals. The blood of white mice dead of anthrax does not kill sheep, but only produces a transitory illness, and the animals are for a time at least protected against the virulent disease." (Klein.)

Pasteur, in his now famous experiments on hydrophobia, at first made use of a similar method. He proved first of all that the disease is to a large extent localised in the nervous system. Thus a healthy dog is very rapidly inoculated by exposing its brain, and then inoculating the surface of that organ with a particle of the brain of a rabid animal. To attenuate the virus he inoculated a rabbit's brain with a morsel of the brain of a mad dog, then passed the disease from the rabbit to a monkey, whence it became attenuated, and a protective vaccine for dogs. His present method is quite different, and consists in inoculating with the crushed spinal cord of a rabbit dead of hydrophobia, the cord being previously exposed to pure air for a certain number of days.

*Antiseptics* and *Disinfectants.*—It has long been known that various chemical substances prevent and arrest putrefaction, and hinder the spread of infectious diseases. In fact, that such was the case was known long before the "germ" theory had been introduced. As soon as it was discovered that putrefaction and infectious diseases are closely allied, and are both caused by

* Troussart.

living organisms, the reason for the action of antiseptics and disinfectants became intelligible. It then became apparent that they act as poisons on the organisms

I do not desire to detain you long on this subject, but there are certain points connected with it of considerable importance which I ought to touch upon. If we take a putrefying liquid and add to it a very small quantity of carbolic acid, corrosive sublimate, chloride of zinc, &c., the putrefaction stops. The organisms are poisoned, and consequently they perish. Similarly, after a case of an infectious disease, sulphur is burnt in the room occupied by the patient, or chlorine is evolved from bleaching powder, everything is well washed with carbolic acid, and the bedding is burnt.

Have all the disease organisms or their spores been destroyed? I am decidedly of opinion that they have not, and chiefly for this reason: that the *spores* of an organism have an extraordinary power of resistance to destructive agencies. Thus the spores of the hay bacillus can be completely dried, and can actually be boiled with water for a considerable time without losing their vitality. It might be argued that the hay bacillus is not a disease organism, and that the latter are more easily destroyed. Possibly this is the case with some, but certainly not with others. Thus it has been proved that a solution of corrosive sublimate—the most powerful antiseptic we are acquainted with—stops the growth of the spores of bacillus anthracis, even when the solution contains only one part of corrosive sublimate to 300,000 of water. But, on the other hand, the spores have not lost their vitality, for Klein has shown that they may be soaked in a one per cent. solution of corrosive sublimate for twenty-four hours, and yet when removed and injected into animals the latter soon die of tpyical spleen fever.

Several years ago Professor Fuller and I tried a number of experiments on the action of gaseous antiseptics, such as chlorine, bromine, the fumes of burning sulphur, ozone, &c., on putrefactive organisms, or rather on their spores, and we were simply astonished at their power of resistance. Bromine ap-

peared to be the most active disinfectant; and I think it might be used with advantage as a substitute for the fumes of burning sulphur, which in our experiments appeared to have no appreciable effect.

It appears to me that a series of complete experiments should be tried with different antiseptics on the spores of each of the disease organisms, for in the absence of the information which would thus be gleaned it is impossible to say how far disinfection is of service. It is perfectly within the bounds of possibility that great differences in the resisting power of the spores of various organisms exists, and that in some cases disinfection is of real service, whilst in others it is mere waste of time.

*5th April*, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

R. Lloyd Patterson, Esq., J.P., F.L.S., read a Paper entitled,

## SOME ACCOUNT OF THE WHALE AND SEAL FISHERIES, PAST AND PRESENT.

The reader commenced by giving a brief historical sketch of the whale-fishing industry, which he said had been discovered or invented by the inhabitants of the Basque Provinces of Spain, in the Bay of Biscay, as early as the 12th century. A whale still figures in the coats of arms of some of the Basque towns; and, long after that portion of the whale fishery which had been prosecuted with much success by the Basques had ceased to exist, the English and Dutch whale-fishers continued to employ Basques as harpooners or "whale-strikers," as they are called in the still extant accounts of Baffin's celebrated voyage, when twenty-four of these men accompanied the expedition in that capacity. After describing at some length the pursuit and capture of the pilot whale (*Globicephalus melas*) at the Faroe Islands, where several hundred of these comparatively small cetaceans are sometimes taken at a single drive, the lecturer alluded to the flourishing state of the Newfoundland whale fisheries up to and about the years 1785 and 1786, when Government paid a bounty of 40s. per ton to each vessel of two hundred tons or upwards engaged in it, and when the number of vessels amounted to between two and three hundred. The trade continued highly prosperous for many years, but from 1840 or thereabouts it declined, owing to the diminishing numbers of the whales and the lower value of the oil, and lost or worn-out vessels were not replaced. The trade languished

up to about 1860, when the application of steam-power to the ships gave it a fresh start, as the vessels were thus enabled to penetrate to higher latitudes and to follow the "fish," as they are called, into previously almost inaccessible haunts. Vessels now go out on combined sealing and whaling voyages. Proceeding first to St. John's, Newfoundland, they ship from two to three hundred extra hands for the sealing voyage. The young seals are born on the ice from about the 15th to the 25th of February, and the aim of the sealers is to find these young seals when they are three to four weeks old, as the oil they then yield is superior to that at any other period of their growth. At this stage of their growth they are called "white-coats," and in the vernacular of the island their pursuit is called "swile huntin'," the hunters being known as "soilers," a corruption of sealers. Mr. Patterson gave a graphic description of the manners, food, and clothing of these men, of their perilous occupation and the chances of success or failure. One vessel, if she be fortunate, may return to port in two or three weeks with thirty to forty thousand young seals on board; while another vessel, equally well found, if unlucky, may be twice the time out and return to port "clean," as it is called, that is empty, having been entirely unsuccessful. Many instances of this were given, and the vessels and their captains mentioned by name, special mention being made of Captain Guy, of the s.s. "Arctic," a native of Larne. After returning from the sealing voyage the vessels refit and proceed to their summer whale-fishing, which is carried on in the usual manner. On this whaling voyage in 1884 several of the Dundee fleet took part, for some time, in the search for the missing United States expedition under the command of Lieutenant Greely. Frequent and most appreciative mention is made of these bold and dashing whaling captains in Commander Schley's published account of the expedition which discovered and rescued Greely and the small remnant of his crew, only seven remaining alive out of the party of twenty-four. The lecturer then gave statistical particulars of the vessels engaged in the trade, and the results of their operations were given for the last six years,

Mr. Patterson mentioning the catches of this present season by the s.s. "Terra Nova" and another vessel. Five of the Dundee and Peterhead fleet were lost last year. For these particulars Mr. Patterson said he was indebted to his friend Mr. George Halley, of Dundee. After some mention of the seal, whale, and walrus fisheries, carried on principally by the Norwegians in European Arctic waters, the lecturer gave an interesting account, derived from his friend Mr. Henry Seebohm, of an important whale fishery that is carried on by steamers, with their headquarters on land on the Varanger Fiord, between Norway and Russia, and also mentioned an important shark fishery that is prosecuted with much success and profit near Iceland. Mr. Patterson next gave a brief account of the abundance of seal life on the Alaskan coasts and Aleutian Islands, in the North Pacific and Behring's Sea, and concluded his paper by a description of the pursuit and capture of the fur seals on the Pribylov Islands, St. Paul's, and St. George, where these creatures are to be found in myriads during the season; but a wise restriction as to the numbers that may be taken is preserving the race from that annihilation that seems to be threatening the seals in other places.

At the conclusion of his paper Mr. Patterson exhibited the skull of a very rare cetacean, the White-beaked Dolphin, *Delphinus albirostris*, the only example of the species the capture of which has been recorded in Ireland. This occurred at Donaghadee, and the record of the capture was made by Mr. M'Gowan of that place.

*5th April*, 1887.

W. H. PATTERSON, ESQ., M.R.I.A., in the Chair.

CONWAY SCOTT, ESQ., B.E., read a Paper on

## EPIDEMIC DISEASES: CAN THEY BE STAMPED OUT?

IN the course of his remarks Mr. Scott said that the great characteristic property of infection is its innate power of reproducing itself or multiplying itself without limit, and, under certain circumstances, without the slightest loss of its deadly qualities. Milk is a medium by which disease is very frequently communicated to persons, and the infinitesimal amount of infection falling into milk has multiplied itself so as to fill the whole milk supply, every glass of which can carry the disease as readily as the original matter. On the whole, there can be little doubt but that the human race has suffered infinitely more from epidemic diseases than from all the wars that have ever been engaged in and all the battles that have ever been fought. The lecturer went on to speak of the organic nature of all epidemic diseases, and said that the late Dr. Ritchie, who was one of the largest-minded scientific men that Ulster had ever produced, was a most thorough believer in the organic nature of all epidemic diseases, and that he more than forty years ago, when these subjects were hardly ever thought of, applied his practical knowledge to the stamping out of such diseases with great success. Mr. Scott then went on to deal with the different modes of disinfection, which means any process by means of which organisms of all kinds are killed, as every process which can kill ordinary organisms will to a much greater extent kill these disease-producing organisms, which cannot be seen, and are only

known by their fatal consequences. If you want to kill any organism, from the highest to the lowest, put it into a fire or furnace. The organism is completely taken up and reduced to gases and vapour, and every spark of life is extinguished. The liquid mode of disinfection consists in surrounding the infected matter with some liquid containing any substance in solution which has the property of killing an organic body. He illustrated this by stating that all the fishermen in a district, with their rods, nets, and lines, cannot destroy all the fish in any particular lake ; but if the contents of some flax dam be emptied into the lake, all the fish, young and old, large and small, will soon be dead, killed or poisoned by the action of the flax-water. The aërial mode of disinfection consists in surrounding and filling the pores of the infected matter with a sufficient volume of gases or vapours which have the property of killing all the disease organisms contained in the infected body or mass of matter. It is impossible to over-estimate the extraordinary effect that even slight changes in the aërial surroundings or environments have upon every organism, from a man down to the disease-producer. The lecturer then proceeded to explain the properties of the different liquids and gases commonly used for disinfecting purposes, referring especially to carbolic acid, whose characteristic property is its extraordinary power of destroying the lowest forms of life. Carbolic acid vapour can be generated by pouring the liquid acid into a hollow tin heater which has been raised to a very high temperature in any ordinary fire, and large quantities of that vapour can be thus thrown off in a very short time. In fact, there is no practical difficulty in generating any quantity of that vapour in any place where there is sufficient fire to heat up the little machine to which he referred. That vapour does not attack the metals, and does not destroy articles exposed to it ; and when moderate quantities of it are used it has no injurious action on the human or animal system, being thus unlike all the other disinfectants of that class. After many years' experience in small-pox, typhus fever, scarlatina, and diphtheria, he can with

confidence recommend this vapour as the most certain means of killing all the organisms which produced epidemic disease. As a matter of fact those organisms cannot exist for any length of time in an atmosphere of carbolic acid vapour. The lecturer then dealt with the disinfection of solid bodies, and gave a number of practical examples of the great utility of carbolic acid vapour as a disinfectant. In a man of drunken or dissipated habits the disease will probably attack him, because his diseased system offers the readiest hiding-place to those organisms. If a man be in a state of fear or nervous apprehension he is nearly sure to take the disease. The fear will reduce his system, and enable the disease to take hold on him. The lecturer concluded by saying that he would on a future date continue the subject, which is an all-important one, and deal with other branches of the subject of epidemic disease.

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